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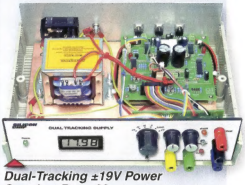

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Publisher's Letter

Unflued gas heaters are a health hazard

The topic of unflued gas heaters might seem an odd one for an electronics magazine but it is relevant to the Carbon Monoxide & Carbon Dioxide Monitor featured in this issue. From an efficiency point of view, using gas for heating is a good idea. It is certainly more efficient than using electricity generated by coal-fired power stations. You avoid the inevitable thermodynamic losses in the steam turbines and all the other losses associated with transmission of electricity from the power station to the point where it is used.

In theory, when you burn gas in a domestic room heater, all the chemical energy in the gas is turned into heat. There are no losses or at least there are none if all the combustion gases stay in the room. But that is not really practical or realistic, is it? If all the combustion products do stay in the room, then the occupants will ultimately die, poisoned by carbon monoxide. I am referring to unflued gas heaters, of course. And if the room is sufficiently well ventilated so that the air is safe to breathe, then the whole process is subject to considerable losses.

There are two ways around this dilemma. First, don't use an unflued gas heater – use a properly flued model which exhausts all the combustion products to the outside air. That works but it does mean that the heater is far less than 100% efficient. It is also a great deal more expensive than using an unflued gas heater, so most people take the cheaper approach.

The second strategy is to use an unflued gas heater with an inbuilt oxygen depletion sensor. This is designed to turn off the heater if the oxygen content is reduced by 20%. These heaters are also considerably more expensive than those without such a sensor. And while there is far less chance of being poisoned by carbon monoxide with heaters which have oxygen depletion sensors, you still get to breathe the noxious combustion products. For most people, this is merely unpleasant, provided you are aware of the characteristic "gas" smell. And in any case, you will normally become accustomed to the smell after a few minutes.

More importantly, the noxious combustion products such as sulphur dioxides, oxides of nitrogen etc can have serious health effects, not least upon those who suffer from asthma and allergies.

So if you do have an unflued gas heater, I would strongly suggest that you consider building or acquiring the above-mentioned Carbon Monoxide & Carbon Dioxide Monitor. Better still, get rid of the heater and replace it with a properly flued heater, a reverse-cycle air-conditioner or an electric radiator.

Problems with our VOIP phone system

Late last year, we had a new VOIP (Voice Over Internet Protocol) phone system installed to replace our old PABX system which had served us well for about 20 years. I felt that the features of the new phone system, combined with the facility of extra out-going phone lines (over the internet) and cheaper phone calls, would be worth the investment.

In practice, it has turned out to be a nightmare because the company installing the system simply were unable to program and fault-find it adequately. I am sure that many readers and clients who have attempted to contact us over the ensuing months have been very frustrated. As we have been!

To all those readers and clients who have been inconvenienced, I sincerely apologise. Thankfully, our staff member Nicholas Vinen has been able to resolve all the programming problems and we now have a VOIP system which functions well.

Leo Simpson

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Foil insulation and CFLs

The whole insulation fiasco has been caused by fly-by-night installers not following standard protocol for the installation of ceiling insulation. There are standards in place which specifically state that insulation of any type must not be installed over halogen downlights and their associated transformers or within a specified distance of exhaust fans. I was informed about these regulations before our ceiling insulation was installed.

Stapling foil insulation into electrical wiring has been the main cause of electrocution of installers and to a lesser extent, others entering the roof space at a later date. (As far as I am aware, RCDs are now compulsory in ALL houses in Queensland, so where were the RCDs in these cases?)

Idiots putting insulation of any type over halogen downlights and transformers has largely been the cause of house fires. Old wiring in houses causes many house fires without the need of adding insulation. The insulation (of any type) just hastens the process.

Regarding electrical wiring in ceiling spaces, we have a modern home, built in 1994, which has a steel frame. The electrical wiring in the roof space is for lights, ceiling fans and exhaust fans. We do not have any halogen (power-wasting) downlights. We have two lighting circuits, one for each end of the house. Both circuits are protected by RCDs (safety switches).

Our meter is on a pole inside our property and we have underground power to our house. The main cable from the meter to the sub-board (housing safety switches and circuit breakers) is in conduit in the roof space (above the insulation). No hot-water heater wiring exists in the roof space.

Our foil insulation has been laid on top of the ceiling battens and between the roof trusses. Access through the roof space is by walking on the roof trusses above the insulation. An air gap exists between the ceiling and the foil insulation. If anything, the foil insulation keeps the wiring cooler by stopping radiant heat from the roof reaching the wiring. The current carried by the electrical wiring is well below its maximum capacity. Access to the actual ceiling or electrical wiring is easily accomplished by simply removing the insulation and replacing it when finished. A recent electrical safety audit carried out on our house revealed that the installation is perfectly safe.

In short, if everything (electrical and insulation) is done according to correct procedures (including the replacement of old and dangerous wiring), then there is no issue. It's the fly-by-nighters wanting to make a quick buck that have caused most of the problems.

Secondly, I have a comment on the lifespan of CFLs. As stated earlier, our house was built in 1994 and the lights originally consisted of a mixture of incandescent bulbs and 20W and 40W fluorescent lights. We rarely had to replace the incandescent bulbs. Some years ago, we started replacing the incandescent bulbs with CFLs in

Spanish solar base-load plants are real

In response to Gordon Drennan's letter in Mailbag, April 2010, "Solar Storage Only A Concept", I would like to direct readers to the power plants Andasol 1 and 2, Extresol and Torresol Gemasolar.

A search of Wikipedia for "Andasol" will turn up the following: "Andasol has a thermal storage system which absorbs part of the heat produced in the solar field during the day. This heat is then stored in a molten salt mixture of 60% sodium nitrate and 40% potassium nitrate. A turbine produces electricity using this heat during the evening or when the sky is overcast. This process almost doubles the number of operational hours at the solar thermal power plant per year. [2] A full thermal reservoir can run the turbine for about 7.5 hours at full-load (375MW), in case it rains or after sunset. The heat reservoirs each consist of two tanks measuring 14m in height and 36m in diameter and containing molten salt. Andasol 1 is able to supply environmentally-friendly solar electricity for up to 200,000 people.[3][2]"

However, Beyond Zero Emissions does not rely on Wikipedia for our information. In September 2009, a group of us toured Spanish solar plants including Andasol, PS10, PS20, Extresol and the best plant of all, a Molten Salt Power Tower under construction near Cordoba called Torresol's Gemasolar.

When finished in December 2010, the Gemasolar plant will have 16 hours storage and run at 75% annual capacity factor. For comparison, the average capacity factor of NSW coal-fired power stations plants is 63% and Victorian brown coal plants is 85%. It is the forerunner to a series of molten salt Power Towers in Spain and the USA of 50-150MW per tower.

This will be the future of power generation technology, coupled with wind power which is the cheapest form of renewable energy as a first dispatch.

Reference: http://en.wikipedia.org/wiki/Andasol_Solar_Power_Station

Matthew Wright,
Executive Director,
Beyond Zero Emissions,
Fitzroy, Vic.

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Mailbag: continued

RCDs no cure for risk of electrified ceilings

Thank you for the interesting April 2010 Publisher's Letter entitled, "The Federal Government's Insulation Scheme Is A Tragedy", in particular the topic of the Federal Government's provision to use RCDs as a preventive measure.

As you rightly pointed out, RCDs have no effect when it comes to the fire hazards caused by overheating downlight transformers. An RCD is a device which operates from leakage current (not heat).

In the case of the fire mishaps, most reputable halogen-lamp transformers are equipped with a thermal fuse that should shut down the transformer if it overheats. However, like all electronic products, not all thermal fuses may work at the right temperature and some may not work repetitively.

I don't think there is a solution at the mains inlet to a household by way of a safety device that can sense rising temperature at a certain location. Obviously such a device can be built but it doesn't make logical sense to have it and to run kilometres of cables to locations whereby their sensors are placed to detect overheating problems such as halogen transformers and it's not a cost effective and rational solution.

The usual circuit breaker only kicks in when the current exceeds the prescribed level of the device. Therefore, I don't think there is an "electrical solution" to the overheating problem of transformers as a result of insulation installed.

I thought that the Federal Government with all their consultants and professional experts would have suggested otherwise on recommending RCDs as a safety measure. A wrongful recommendation is a liability and certainly a major issue when lives are at risk. I hope the removal of insulation is proceeded with as rapidly as possible, as opposed to the installation of RCDs.

Michael Ong,
Wembley, WA.

order to save power. We found that our power bill went down marginally with using the CFLs but we also found that we were replacing the CFLs far more frequently than we had been replacing the incandescent bulbs.

The idea that CFLs outlast incandescent bulbs by a factor of eight is a myth. They often don't last as long as incandescent bulbs, despite costing up to 10 times the price. So CFLs can be false economy. You might save a little on power but you pay for it in much higher replacement costs.

Bruce Pierson,
Dundathu, Qld.

False notions of high fidelity

Reading through Steve Adler's letter about digital radio (May 2010 issue), I was struck by the phrase "so good you can hear the announcer breathe". Oh spare us from this notion of high fidelity! This old broadcasting man is fed up with the current fashion for radio people nearly swallowing the mike and treating us to popping Ps, clicking saliva and breath noises.

You'd think the ABC would know better but some of their classic FM presenters (otherwise admirable) are among the worst offenders – anything with a P in it brings an annoying whump from the speakers (top class gear, no bass boost). The puzzling thing is that no announcer has to work so close to the mike in a soundproof studio with no background noise. So why do they do it?

Brian Wallace,
Dora Creek, NSW.

Use low discharge cells in digital cameras

With reference to the letter from G. H. of Mount Martha, Vic, in Ask SILICON CHIP, May 2010 ("Digital Camera Won't Work With Rechargeable Cells"), I had a similar problem with NiMH batteries in a Pentax K-x SLR which uses four AA cells. The problem was well known and Pentax issued a firmware update to handle the lower voltage of the rechargeable cells. Olympus may have a similar firmware update.

However the Pentax upgrade did not completely resolve the issue which also related to the variable internal resistance of these cells. The solution is to use high-quality, low discharge cells such as Sanyo Eneloop which apart from being low discharge also appear to have low internal resistance. I have been using these cells for a month and they have never let me

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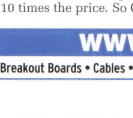

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The best of DAB+ is not available

Thank you to Steve Adler for his lucid defence of what might well be ABC current DAB broadcast policy, in the Mailbag pages of the May 2010 issue. I am somewhat surprised then, that having rejected the BBC DAB standard as outdated and anecdotally of poor audio standard, that he should then use it as a reference of acceptability when evaluating DAB+ in its various levels of compromise. Where is the sense in that?

A better argument is needed to convince us here, as logically, he appears to advocate a broadcast audio quality which at best is scarcely above "outdated and poor sounding". I accept the need to preserve bandwidth for future allocations (will we really need 100s of AM talkback programs?) but I think it dull rationalism to prune and squander the potential for higher quality audio reception that lies before us in our expensive new tuners, car radios and sound systems.

We once proudly adopted the highest feasible broadcast standards. It now seems though, that in our usual haste to replicate BBC policy, we are losing a key benefit of DAB+. The reception benefits, in my own limited experience, are frequently as poor as FM and frankly, I am quite happy for the AM "shock jocks" to die a bit in the expressway tunnels!

Ian Finch,
Urunga, NSW.

down. They work just as well as the lithium batteries at a fraction of the cost.

Malcolm Fowler,
Mount Eliza, Vic.

Extra safety check for EHT probe

I have one more suggestion to add to your safety precautions for using the EHT Stick (SILICON CHIP, April 2010): measure the loop resistance from the positive output lead to the place where the earth lead is clipped on each time the probe is used and make sure that you return the meter back to the volts scale before measuring voltage.

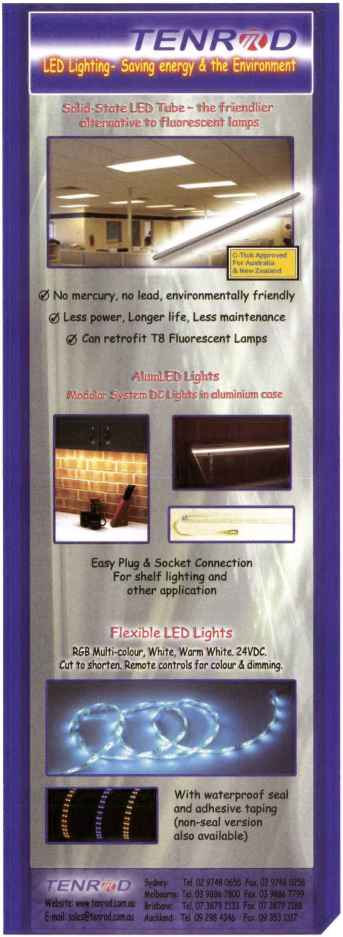
Although it is most unlikely that something will go open-circuit in this loop, it will be bad news if it does.

Alex Brown,
Ashburton, Vic.

Driveway Sentry project revisited

The letter in the Mailbag pages of the March 2010 issue, about the failure of Driveway Sentry coil, triggered my memory of what I went through to get a solar-powered remote version to work, some five years back.

My application was for a 1km-long driveway at a vineyard in the Hunter Valley, to warn house residents that a vehicle was coming up the drive. I had been experimenting with a solar-powered PIR and 433.92MHz coded Tx/Rx modules for some time. I finally achieved the range by



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Mailbag: continued

Digital TV picture quality is better than PAL

John Hunter's letter on page 10 of the May 2010 issue mainly bags digital television and he makes the statement that he does not know anyone who feels 625-line PAL transmissions are lacking in quality.

I will agree that there are some standard definition TV pictures that are not as good as 625-line analog TV. This is often a function of poor digital copies or poor transmissions paths. Overall, good standard definition digital TV is better than analog TV.

The video signal-to-noise with analog TV is between -40dB and -50dB at its best. SD digital can come close to -60dB and HD can be even better. However it does require all things to be correct to achieve this picture quality.

High definition pictures converted to SD presents SD digital at its best although I will agree that the resolution of SD digital is sometimes not as good as analog. Have a look at the green grass at football matches. The wide shots show the grass as a smooth blurred carpet.

So you can argue that analog TV at times is better than SD digital TV but HD (high definition) blows analog out of the water. I watch a lot of HD movies (1080i), mainly on Foxtel and BluRay DVDs (1080p). I don't find any difference between 1080i or 1080p; after all there is no extra resolution, just double the frame rate from 25 to 50.

The resolution, along with the complete lack of noise, over-shoot, under-shoot or any digital artefacts is amazing. The picture is perfect; far better than what you see at the movies. There are real blacks, not the grey you get at the movies and no shutter jitter. Added to this, I can and do record SD and HD programs in perfect copies on HDD for viewing later.

Will McGhie,
Lesmurdie, WA.

using a Yagi antenna on the transmitter but I could not make any of the 12V PIR sensors stable in all weathers and temperatures.

After purchasing and building the Driveway Sentry kit and using the relay output to drive the transmitter module, supported via a 1.2Ah SLA battery with an AA-0348 charging regulator fed from a Suntech 2W solar panel, I had a working system.

I had to refit it into a weatherproof box but everything worked fine. Unfortunately, the Driveway Sentry pulled too much power in standard configuration and flattened the battery in about three days, even in sunny weather. That was puzzling, as the sensor itself is virtually passive.

I then rationalised the Sentry circuit to reduce power use by removing the 12V relay and feeding the transmitter module directly from pin 3 of the 7555 timer IC. I also removed IC3, IC4, REG1 and the power LED. Finally, I installed a phone charger power supply card between the battery and the control board, replacing the regulating resistors with a multi-turn pot to adjust it to exactly 6V. These can be bought for about $15 and have an efficient chopper regulator; much less power hungry.

Current consumption dropped to 4.7mA on standby and 7mA when triggering. This will do about 10 days in complete darkness, so is well within the battery and solar panel capabilities. The control card is now quite bare, with only the op amp and timer chips loaded.

The receiver end in the house is a plugpack-powered box with the receiver module and a small piezo ding-dong siren. I put a small transistorised relay on the data signal output so the siren could get full voltage. A straight 14.3cm cheap telescopic antenna is used. This will easily convert to an outdoor Yagi if more range is needed. I am transmitting 450 metres at the moment, halfway down the drive, as it was felt that mounting at the driveway entrance at 1km was likely to attract vandals to the solar equipment.

The transmitter end is a Yagi design I downloaded off the net. It is built

from 10mm aluminium tube and a piece of PVC pipe, all glued together and trimmed to exact 433.32MHz dimensions.

The unit has performed well for five years but I did have to replace the SLA battery after four years. After three years, the sensing coil went open-circuit. I dug it up and opened it to find the iron bar within the coil had rusted and burst the copper coil. I found a new piece of iron rod and passivated it and painted it with bitumastic before winding a new coil on it. I then filled the whole housing with bitumastic putty. It has worked ever since. It certainly isn't rocket science.

Robert J. Burns,
East Gosford, NSW.

Caravan charger/booster wanted

On page 100 of the March 2010 issue, reader N. R. was wanting to charge his caravan battery from his vehicle. I would like to weigh into this too, if I may. I have had the same problems as N. R. and understand his reluctance to spend over $500 on a vehicle-to-caravan battery charger. The one he has looked at appears to be suitable for the job. There are other cheaper units available that just provide a float voltage for the caravan battery of 13.8V with inputs from around 8-16V.

To overcome the charging problems, I increased the size of the cables between the vehicle battery and the caravan battery. I use two 8-gauge cables for the positive line and the vehicle and caravan chassis where possible for the negative line. I use just one 8-gauge cable for the flexible coupling between the vehicle and the caravan A-frame for the positive lead and one 8-gauge for the negative.

Don't trust the ball coupling to provide a good negative return. I use an Anderson-type connector rated at 50A which is more than adequate for the job. With thermal circuit breakers it is desirable to check the voltage drop across them under load. I use a small thermal link instead. The voltage drop I have to the battery in the caravan is 0.5V with 20A of current.

While the cables used by N. R. may be rated at 30A, mine are each rated at 56A, giving 112A in total. It is not the current rating that is important; it is the voltage drop for the length used. The cables and connectors are available from SILICON CHIP advertisers and auto and caravan places. Check the prices though; they vary considerably.

With the upgrading of the cabling between the vehicle and the caravan I find it only necessary to charge the battery every few days when staying infrequently at a caravan park. The vehicle charging system will maintain it at a reasonable charge level whilst travelling for days at a time. And it is cheaper and works well for me.

Like N. R., I would like to see a suitable up-converter with a multi-stage charging regime from the vehicle to charge the caravan battery. It would be great if it was also capable of doing this from the mains as well. To really raise another interesting point, it could run from solar arrays too or have provision for that facility.

Rodney Champness,
Mooroopna, Vic.

EHT probe for DMM, April 2010

This is a well-thought out article, especially the safety warnings. I would however suggest that the assembled PC board be coated in a suitable lacquer before fitting the heatshrink sleeving. This will give long term protection from dust and humidity.

Rodger Bean,
Watson, ACT.

Banana to banana leads are available

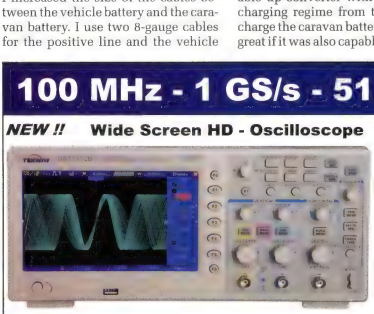
I have a comment on the sidebar on page 74 of the March 2010 issue ("Connecting to your DMM: another approach") and your bemoaning the lack of banana to banana leads. I would draw your attention to page 142 of the Altronics catalog bundled with that issue and the product coded P0414 "Shrouded Banana Leads".

Failing that, look in the Jaycar catalog, supplied with the April 2010 issue of SILICON CHIP. On page 124 can be found product coded WT-5326 "High Quality Banana Piggyback Test Leads".

Admittedly these are both tagged as "New" items but in fact seem to be more a return of an old product. I got my piggyback leads years ago from Dick Smith Electronics. Why these

100 MHz - 1 GS/s - 512K/ch - $1,495 ex gst

NEW !! **Wide Screen HD - Oscilloscope**



With an incredible 800 x 480 pixels the DST1102B has 5 times the number of pixels than others in its price range that typically offer just 320x240. You would not go back to VGA on your PC so why accept yesterday's display resolution on your new DSO? See this display to believe!

The max update speed of 2,500 waveforms per second and the fast bright TFT display means you will not suffer from the sluggishness of the low-cost back-light LCD's on typical competitors' products either.

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should be an item of fashion I don't know.

Also, hooray for the Macbook review! Judging from the Mailbag backlash, it's precisely the sort of thing needed in the pages of SILICON CHIP to challenge a few blind prejudices. I suppose one shouldn't expect the technically minded to like a computer that, out of the box, is running Unix overlaid by the best GUI available and ready to install Windows if required.

Mark Williams,
Enmore, NSW.

Diodes can degrade to zener-like behaviour

With reference to the letter from Colin O'Donnell on page 6 of the February 2010 issue "Detecting A Dodgy Diode", yes, diodes can become zeners!

With my almost 50 years experience in electronics, I have many times found diodes that measured OK but when replaced, that fixed the issue I was having. But I had never stopped to investigate why.

Not too long ago, I was repairing a faulty radar transceiver and after identifying the faulty area, no faulty component was found with "conventional" measurements. As I was 99.99% sure that a 1N4148 diode was the culprit, it was removed and tested OK but was replaced, just in case. The radar unit sprung to life! When I had a look at the diode and tested it with a DMM and power supply, it behaved normally on forward bias. As soon as I tested it on reversed bias, I found that it was behaving like an 8V zener diode.

Manuel Gonzalez,
Blackburn, Vic.

Earth resistance can affect core balance relays

This story might be of interest to readers, as it relates to problems associated with core balance circuit breakers, now commonly called residual current devices. In the early 1970s, earth leakage core balance units were not common in Australia, though I'm told they had been in use in South African mines for 70 years. I managed to obtain a unit and chose the most sensitive 20mA model. This protected all five power circuits which of course made fault-finding much more difficult; today each circuit has its own device.

Our very expensive 8-year old Miele washing machine started tripping our core balance unit, when it moved onto the heating cycle. My assumption was that it was caused by leakage to earth on the heater element. The serviceman was very thorough but could not fault the heater element, which didn't give a low reading to earth, however he then replaced it and the problem persisted,

As a desperation move I tried the machine in another GPO (I have three circuits in the laundry) and this revealed no problem, so the serviceman left with my $260. And I now had a perfectly good secondhand heater element I'm never likely to use.

I eventually tracked down the problem to the treadle control on my jeweller's lathe in my workshop. This is adjacent to the laundry and is coincidentally on the same circuit. Although the power was turned off, the Neutral wire had been crushed onto the earth wire in the power plug, as some timber had fallen onto it. Under light loads this return current path wasn't sufficient to trip the breaker. However, when a heavy load was put on the circuit, enough current leaked to earth to trip the breaker.

The only good news from this expensive and rather embarrassing experience was the revelation on opening the machine up – it was still in beautiful condition.

John Pitcher,
North Epping, NSW.

High-voltage transformer cores an innovative solution

It was interesting to see three separate references in the April edition to the Philips Radioplayer 124 and its speaker transformer: Brian Coulson in Mailbag, in Serviceman and in Vintage Radio by Rodney Champness.

Back in the 1950s, as a high-school student working towards university and an electrical engineering degree, I was hungry for any information I could get. Rola Pty Ltd would publish very informative speaker catalogs on a regular basis and the last two or three pages were given over to their range of speaker transformers. This was one of the publications I would read avidly at the time.

Not surprisingly, Rola gave considerable emphasis to their unique transformer design and indeed published, on at least one occasion, a detailed analysis of how the design was reached.

Rola cited a high incidence of open circuit primary

windings in speaker transformers, very high by comparison with other signal transformer applications. Remember that by that time, interstage audio transformers had all but disappeared. They apparently researched the phenomenon and attributed the comparatively high failure rate to the incidence of three factors.

First, there is a high quiescent voltage between the winding and ground of the order of 300V, plus impressed signal voltages which might give a peak voltage of almost twice that figure. Second, the enamel insulated winding wire was prone to pin holes in the enamel. Urethane-based enamels largely fixed that issue but they came much later. Third, no matter how hard one tried, there would always be some moisture absorbed into the insulating materials, especially in a radio that was being used in the kitchen!

As a result, it was reasoned that on a statistical basis, it was possible to have a pin-hole of bare copper energised as a +300V sacrificial anode. In the presence of moisture, this could lead ultimately to a complete loss of the copper by electrolysis, the result being an open-circuit winding.

Three responses were possible: (1) ignore the issue as trivial, as competitors did, probably driven by patent considerations and as was done in economy radio sets which continued with open "E-frame" transformers; (2) vacuum-dry the transformers and heavily varnish them, as was done by some European manufacturers. Rola acknowledged this technique but described it as largely palliative, producing results little better than untreated transformers; (3) resolve the problem by removing the highly energised anodic condition – and run the trans-

Caning suggested for designer of Digital Audio Recorder

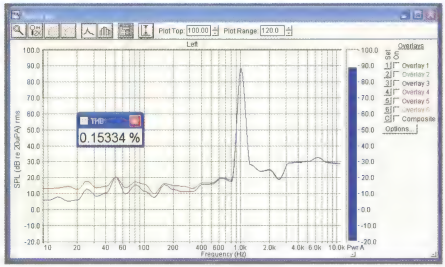
I have recently built your SD card Digital Audio Recorder/Player (Silicon Chip, August 2009) and would suggest that you take a large cane to the person who designed the PC board. With the board layout as it is there is almost no way of successfully building the thing into a case with access to the switches and LCD display. Pretty please, can you organise the PC boards for future projects with some thought to the final user access to the controls?

For example, the LCD and switches could have been on a sub board which could have then been mounted to an instrument case front panel. When I build these projects I like to finish them off in a professional manner and there is no way this can be done with the existing PC board.

Tony King, VK3API,
Lilydale, Vic.

Comment: caning is not always conducive to good employee morale. We took a deliberately utilitarian approach to this project which is why there is no case – just a bare bones PC board. Yes, we could have designed it to go into a particular case but that would have made it considerably more expensive.

Mailbag: continued



Improving the Digital Audio Oscillator

While I agree with the magazine's response to the question "Improving the Digital Audio Oscillator" in the Ask SILICON CHIP pages of the February 2010 issue, I don't think the reply is as complete as it could be.

The Digital Audio Oscillator (SILICON CHIP, June 2009) uses a classic 8-bit passive 2R/R DAC followed by the op amp in question. In theory, if the waveform is accurately defined in the processor's lookup table, the maximum error should be ±1/2 bit, ie, a maximum quantisation error of 1 in 512.

By my calculations (ie, 20 x log(1/512)), that should give a "best possible" signal-to-noise ratio of -54dB or a best possible sinewave distortion of 0.2%. It turns out that this figure is achievable. The writer to Ask SILICON CHIP might have better put the question "Why is the oscillator's distortion no better than 3-4%? Will it help if I change the op amp?"

Your answer is correct – the LM-358 is OK for this design but it is limiting the overall performance. The LM358's noise and distortion performance doesn't make things worse but its slew rate is a problem for the square-wave waveform at the top end. It can be as bad as 0.25V/µs rise/fall time according to the NatSemi specification sheet I looked at.

I have just finished designing and building a variation of this type of DDS (Direct Digital Synthesis) oscillator, using a cheaper ATtiny2313 micro and the same D/A ladder, followed by a TL072 op amp (with better slew rate!) with isolated main and inverted outputs. It also employs a way to get a reversed sawtooth/ramp waveform without the need to use another 256 bits of ROM. This gave much better distortion performance – 0.2%, as expected.

The attached spectrum sweep screen grab was taken using soundcard-measured SpectraPLUS demo software, so the measurement is hardly precise but the figures are likely to be within the ballpark. The 0.15% figure reported is probably better than expected because of the sharp filters in the sound card cutting off above 11kHz.

Inspection of the waveforms in the photos in the original SILICON CHIP article (June 2009, page 72) suggests the distortion problem probably lies in the waveform coding tables. The sinewave looks decidedly "peaky" and probably has a good load of second harmonic going on in there. The triangle wave clearly looks quite distorted too, as does the sawtooth. And if you can see it, the distortion is probably already hitting several percent.

The Altronics design could be considerably improved by two simple changes: (1) correct coding of the sinewave table in the ROM and (2) changing the LM358 to the TL072 or similar. In addition, unless the core code routine in the Altronics code is otherwise limited in some way, the oscillator should then also quite happily go up to 65kHz rather than the present design limit of 30kHz.

A further useful change might also be to swap the 78L05 regulator for an LP2950 which would give a modest improvement in battery life.

I made one other major addition in my oscillator. I hate pushbuttons for frequency selection (pressing UP/DOWN to select 27,345Hz for example, which you also can't do with this design, limited as it is to 500Hz steps above 1kHz), so I added a rotary encoder. It's got an SPST switch built-in, so pressing it down selects 1, 10 or 100Hz tuning steps anywhere across the 1Hz to 65,535Hz range, so tuning to 27,345Hz is much easier.

Finally, don't take this as criticism of the original article. It's a useful design and it spurred me on to crank out my version. I appreciate Altronics devoting the time to produce the kit. Really, this email is only intended to suggest that the design can probably benefit significantly from a couple of very low-cost changes.

Andrew Woodfield,
Christchurch, NZ.

Comment: good analysis, Andrew. We have passed your comments to Altronics.

former core at the B+ supply voltage. This was Rola's unique and apparently effective product differentiation.

So the reasoning for the high-voltage transformer core, insulated by potting the transformer in pitch, is rather more complex than simply preventing flash-over between winding and core. And as the rust showing in the picture by Rod Champness shows, the transformer can was made from drawn steel, not aluminium. In many cases, the standard finish made them look much like aluminium and the impression that they were made of

aluminium is quite understandable.

I am indebted to Brian Coulson for reminding us of the marketing name "Isocore" used by Rola for this transformer series. I knew there had been one but I had completely forgotten it.

Max Williams,
Ringwood, Vic.

Comment on roof insulation scheme

In your Publisher's Letter in the April 2010 issue you labelled the Government's insulation scheme as a tragedy. I most strongly disagree.

My home is all the better for the insulation that was provided thanks to the Government's insulation scheme and I am now enjoying reduced energy bills, which benefits everyone.

It is a tragedy that homes suffered from bad insulation installation but there's the whole point. Is it the Government's fault that some greedy individuals decided to cash in on the scheme and go installing insulation incorrectly and with no real knowledge of the insulation process? I inspected what my installers were installing and I didn't want foil coverings (as mentioned, if installed incorrectly it's a hazard). Also there was no nail gunning required – just cut to size and install. This was performed successfully and I am eternally grateful to the government for this insulation.

The blame should fall solely on the installers. If they didn't know what they were doing they shouldn't have done it in the first place. If I go and install a shed or building fixture and tell someone I can do it, I have taken the action into my own hands. Can the government police everyone who goes around performing work for others correctly or incorrectly? No. You are always going to have illegal, dodgy and incorrect work going on. Sadly this is the world we live in.

The arguments that the government should have policed it better and made sure of safety etc are beyond belief. At some point we must all take responsibility for our own actions and crucifying the government for some unscrupulous dodgy installers is not only unfair, it's just not right.

The scheme was a good one and despite these fire issues I'm sure the benefits will outweigh the unfortunate negatives caused by labour work outside of the government's control. It was money made available to insulate all non-insulated homes. This is a fantastic gift and it's unfortunate that it was abused by money-hungry people who didn't really know what they are doing but this is life.

The insulation scheme was not a tragedy but a bold move to try and assist our entire society at large.

Sean A. Curtin,
Runcorn, Qld.

Comment: we fail to see how a reduction in your energy bill is a benefit to everyone. If there is any reduction, it will be a personal benefit to you and a large cost to the taxpayers.

The entire scheme was badly conceived and will have a legacy of house fires and possibly more deaths for decades to come. That the government was warned about the risks only compounds the tragedy. SC

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UAVs: an Australian perspective

By BOB YOUNG

Most readers would be aware that UAVs (unmanned aerial vehicles) are used extensively for surveillance and for bombing missions in Afghanistan and Pakistan. But did you know that UAVs are being made in Australia? Not only that but they are being sold around the world for a range of applications. The manufacturer is Silvertone, a company with decades of experience and run by Bob Young.

Silvertone's latest UAV is the 4-metre wingspan Flamingo, shown above in a hangar at Bankstown airport with a slightly larger cousin. The Flamingo is a lightweight, modular unit designed to operate in the under-20kg class of UAVs, thereby avoiding the complications and costs of larger UAVs which are subject to more stringent Civil Aviation regulations.

The modular construction makes the Flamingo extremely versatile, allowing a variety of mission configurations as well as making it easy to transport. Broken down into its separate components, the Flamingo will easily fit into a family sedan.

While it is a relatively small UAV, it can carry payloads double the weight of its air-frame. It uses a small motor, rated up to 3.5HP driving a 16-inch (diam) x 8-inch (pitch) wooden propeller, giving it a maximum speed of 78 knots (144km/h) and maximum ceiling of 15000 feet (4500m).

The Flamingo is a pusher prop aircraft, as are many larger UAVs. Pusher aircraft have several advantages over tractor aircraft, particularly when used in surveillance aircraft. They give an unrestricted view forward for the camera as well as being more aerodynamically efficient. The efficient aerodynamic design gives vice-free flight characteristics combined with an excellent speed envelope, making the Flamingo an ideal UAV trainer.

The aircraft's endurance is rated up to seven hours, depending on payload, throttle settings and altitude. And while 15000 feet is the ceiling, in practice this is set by the

Silvertone Flamingo F-08 UAV kitted out for real work. Note the antenna arrays

quality and range of the optics used in any surveillance video cameras. The most efficient altitude for flight is around 11000 feet which gives 25% of the fuel consumption achievable at sea level.

As well as its modular design, the Flamingo has a large payload area (in front of the propeller) which has a bolt-on pannier which may be replaced to allow the aircraft to be re-configured quickly for different missions. The pannier can be constructed to suit the customers' requirements, with the payload mounted above, below or with the Pannier plate mounted vertically, on each side. Overall, the pannier has been optimised for surveillance equipment.

Maximum payload is 10kg while the all-up weight (AUW), which includes airframe, fuel and payload is 20kg.

Undercarriage

Because the Flamingo will be employed in a variety of situations, its undercarriage may be configured in three ways:

(1) Fixed undercarriage. This is ideal for local missions, pilot training and other tasks where landing and take off requires a fixed undercarriage.

(2) Drop off dolly. This configuration is mandatory for long range, long endurance missions. It gives maximum aerodynamic efficiency and the fuselage is tough enough to permit belly landings on return. This configuration is also ideal for catapult launching.

(3) A small single wheel fitted to the fuselage as in full size gliders.

(4) The single boom configuration allows the safe use of the more efficient wooden propellers even with the drop-off undercarriage.

Endurance & speed

The 5.6 litre fibreglass fuselage fuel tank gives an endurance of up to seven hours depending upon factors such as the aircraft all up weight (AUW), motor type and size, throttle setting etc.

As noted above, top speed is around 78 knots (144km/h) while cruising speed is around 52 knots (96km/h) and stall speed is about 24knots (44km/h), so the speed range is of the order of 3:1. These figures are dependent on the motor fitted and the payload.

The Flamingo is designed to handle winds up to about 17 knots (32km/h) with safety.

The Flamingo is designed for local and export markets, including the following applications:

- Pastoral live stock inventory & mustering.
- Agriculture – farm management; crop growth; crop damage; water storage.
- Environmental monitoring; fence damage.
- Security/Military – surveillance; intelligence; target drones.
- Real Estate/Mining – property images/mine layout/ environmental monitoring

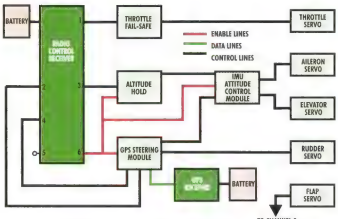
Practical aspects

The Flamingo has been used in a variety of applications. It was entered in the 2007 Outback Challenge and was fitted with an Ezi-Nav autopilot manufactured by Dave Jones of AUAV, Florida USA (www.auav.net).

Flamingos have been sold to various Universities, private individuals, the Royal Thai Air Force and the USAF and are all out there doing useful and very interesting work. For example, a Flamingo F-08 belonging to the Queensland University of Technology is fitted with a Micropilot autopilot and has at various times been controlled via the 3G telephone network. It has also clocked up a lot of hours doing collision avoidance under the Smart Skies Project (www.smartskies.com.au).

Broken down into its separate components, the Flamingo will easily fit into a family sedan.

The twin boom Flamingo F-15. Note the canopy style access hatch on the nose-cone and the three blade prop fitted to the larger Saito FG-36 four stroke engine.



Block diagram of the Flamingo Autopilot showing the essential control elements.

Ezi-Nav modified by Silvertone to include IMU and 2.4GHz receiver.

This is part of an ongoing worldwide project aimed at integrating UAVs into shared air space, ie, occupied by both UAVs and manned aircraft. The successful integration of UAVs into shared air space is currently a major concern of aviation authorities all over the world.

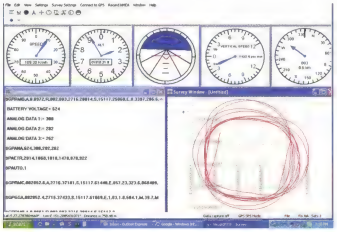
Small UAVs are being touted as economical solutions for such tasks as border surveillance, crop health analysis, livestock and wild animal survey, traffic monitoring and even as a monitoring system for game poaching in Zambia.

The concerns of aviation authorities in regard to small UAVs are easily understood. Capable of ranges in excess of 500km and able to operate at altitudes of up to 5,000 metres under full autonomous control these are no longer model aeroplanes. A 20kg UAV colliding with an airliner does not bear thinking about!

If UAVs reach the levels of acceptance that proponents have in mind for them, then air traffic control will take on a whole new meaning. Add to this the concerns of authorities in regard to misuse by terrorists and it becomes perfectly obvious that UAVs must be handled with great care.

Guidance

The Ezi-Nav fitted to Flamingo F-05 comprises a series of software modules, which together with solid-state sensors combine to make up the autonomous flight control system.



Ezi-Nav Ground Control Station showing instrument displays and mapping data.

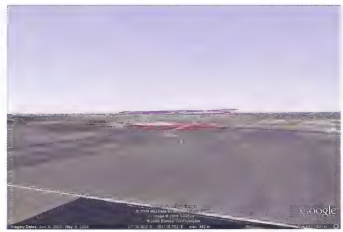
The autopilot software features a GPS steering module, the altitude hold module, a solid-state attitude hold module plus various navigation and housekeeping modules. There is also provision for a data modem uplink/downlink.

In the Flamingo, a real-time video downlink system with a video overlay can be fitted. The overlay displays groundspeed, altitude, compass-heading, GMT time and GPS location in real time on the ground control station monitor. There is more on the video installation to follow.

The Ezi-Nav can also provide a complete and more traditional data downlink giving the Ground Control Station with such data as speed, altitude, battery voltage, engine RPM and a host of other data as well as mapping information.

The data link, when combined with the autopilot log file, can provide some very interesting information. For example the photo below is a track-plot overlaid on Google Earth but rotated to show the UAV flight path from a horizontal viewpoint.

Now the interesting thing about the photo below is that the white path shows the flight-path under manual control and the purple path shows the flight-path under autonomous control. Looking closely, you will notice that the white path leaves the airfield after take-off and during climb to altitude and then switches to purple when auto



Horizontal view of a track-plot overlaid on Google Earth. This UAV came down rather more quickly than it went up!

Finished Ezi-Nav. Note the tiny receiver antenna (left side) and neat wiring installation.

Dave Jones (AUAV) working on the Flamingo F-05 prior to the Outback Challenge 2007. Note the ease of access to the avionics using the pannier style nose configuration and a sensible stand.

mode is switch in. But where is the white track tracing the flight-path back down to the landing?

Uh-oh!

There isn't one, because the autopilot (no, not an Ezi-Nav) failed in flight and the UAV dived vertically into the ground from 600m, destroying it and all of the components on-board, including the autopilot.

So we have no way of knowing what failed except for the log file transmitted back to the ground prior to the crash that clearly recorded the fact that the autopilot stopped generating the log file probably at the same time as it stopped flying the UAV.

It was a shattering experience in more ways than one and drives home once again the fact that choice of reliable components is a vital element in the success of any project.

So back once more to the Ezi-Nav. The microprocessor-based GPS steering module receives output data from a dedicated GPS receiver and converts it to an R/C servo position command. The GPS receiver provides the raw GPS data to the autopilot and the autopilot performs the navigation calculations and manages waypoints and routes. Simply connect the dedicated GPS to the autopilot and it will translate the track/bearing error into a servo position command. This module also corrects for cross-track error so it will stay on course for long distance navigation in heavy crosswinds.

The Altitude hold module is pre-set in the flight planning stage. The waypoint data contains an altitude parameter that will instruct the aircraft to climb or descend while on route to the next waypoint. In order to achieve this it may be necessary to insert a loiter command to allow the aircraft time to arrive at the defined altitude. The Ezi-Nav is also fitted with a waypoint management system that allows waypoints and altitude data to be uploaded in flight via the data modem if required.

When uploading waypoints, most small commercial Autopilots are restricted to 300km radius of operation due to Government regulations and will automatically return home if this distance from home is exceeded.

Using the GPS-enabled system with an attitude control unit (optical or IMU) and an altitude hold makes it possible for an aircraft to be sent off on a fully automatically controlled mission to any point within range of the aircraft. Manual control via the transmitter is only required for take-off and landing. The transmitter may be switched off for the rest of the flight. Autonomous landing and take-offs are very difficult to achieve reliably and it is best to stay with manual control for these functions in low-cost UAVs.

To get the modules to automatically take control when the R/C radio loses command signal or is switched off deliberately, you need to use an R/C system that comes with a built-in fail-safe and servo hold (preset) feature. The autopilot-enable channel is programmed so that the fail-safe will activate Autopilot Enable once the transmitter is switched off or fails. From this point the UAV is in full autonomous mode.

Video downlink

One of the big problems facing civilian UAV operators is that of restrictions on RF power and frequency allocations suitable for use in UAVs. The most serious of these is the video transmitter output power legally allowed on the commonly used 2.4GHz ISM band. While the UAV is free to roam across vast tracts of terrain, getting back real time video images using transmitters abiding by the Australian

A circular tracking plot painted over a Google Earth display. The Aircraft used was the Silvertone Aero-commander, a very fast (120kph) small UAV. An excellent plot recorded on quite a windy day. The red track is part of a proposed flight plan to be flown at a later date.

legal limit for analog FM video transmissions of 10mw effectively clamps the operational range to only hundreds of metres – that is, if you want to see what is happening in real time on the ground.

If the application can tolerate stored video to be reviewed at a later date then that really is a very nice way to do it, as the video images are of a much higher quality and well worth waiting for.

Another avenue is stored still images spliced together in a photo mosaic such as shown below. The mosaic below is made up of a series of near infrared stills used in agricultural survey to determine crop health.

The type of system outlined above is ideal for special projects where real time images are not required. The more typical UAV missions such as fire detection, traffic management or surveillance do require real time images. In keeping with the requirements for these missions, the Flamingo is fitted with a real time video downlink.

The block diagram opposite shows the basic layout of the various components.

There is one further aspect to video and that is First Person View (FPV) wherein the pilot flies the aircraft out of sight using an attitude control combined with a video downlink. There need be no autopilot used in this system, therefore it falls more correctly into the RPV (Remotely Piloted Vehicle) category.

The IMU or optical sensor keeps the aircraft level and the flying is done via virtual reality goggles or just simply a good video monitor. There is an enormous amount of interest in this aspect of R/C flying as it removes the "fly-around-in-circles" element from the typical old-style flying session.

Once again, however, governing bodies become hypersensitive when confronted with this sort of thing and exert their muscle via the insurance policy. It is however very exciting once you are involved. This system combined with an autopilot is a potent combination as each system provides back-up for the other. In the event of an autopilot failure the aircraft can be flown home visually provided the control receiver is still in range of the transmitter.

Antenna array used in the Outback Challenge 2007. This array included antennas for the video, radio control and duplex data transmitters.

The video system

The heart of any video system is the video camera and we recommend the best that can be justified under the project budget. One of the frame grabs shown below was taken with a 625-line camera and even that is of quite poor quality compared to the stored video. Vegetation suffers

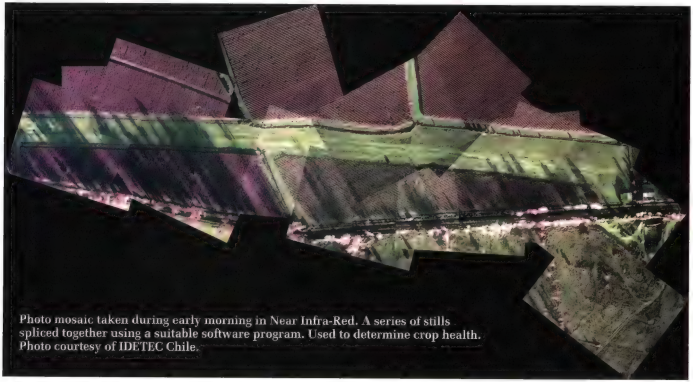
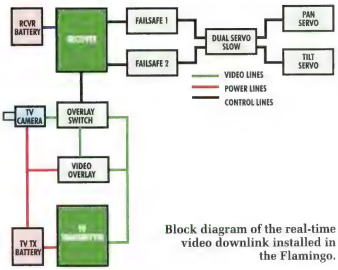


Photo mosaic taken during early morning in Near Infra-Red. A series of stills spliced together using a suitable software program. Used to determine crop health. Photo courtesy of IDETEC Chile.

Xtend Modem used in the Flamingo for the 900MHz data link



Block diagram of the real-time video downlink installed in the Flamingo.

very badly with low-resolution cameras.

By far the best quality video is obtained with an on-board digital video camera and using a low-resolution real-time mini camera as an aiming guide. There is always the risk of the loss of a very expensive camera but that has to be balanced out by the results obtained.

There is another method for real-time video coverage using the mobile phone system but for this to work the UAV must obviously be operating inside the area covered by the phone network.

Interestingly enough, Digital Spread Spectrum (DSS) video transmitters are legally allowed up to 4W – the problem is finding a good commercial unit at a reasonable price. There is an excellent dual diversity, digital unit available but the price is around US$25,000 and this is only for the video transmitter and receiver.

A good gyro-stabilised, GPS targetable optical and infrared camera which is integrated into the autopilot, can cost as much again. The DSS video TX/RX unit above will work over ranges in excess of 50km. Even that range is still short of the range of the UAV so unless UAV operators can get access to real time satellite image transmission the effective operational range of the small UAV is governed by the range of the real time video link.

As shown in the above block diagram, the system begins with the TV camera (with a cameraman seated at a ground video monitor). The video output is fed into a relay-switching module, which either routes the video directly to the TV transmitter or through a video overlay unit. This relay is controlled from a separate video control transmitter, along with the signals to control the pan and tilt servos for the camera.

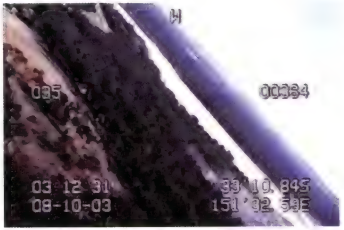
Alternatively the camera may be integrated into the autopilot for GPS targeting or even a combination of both. The camera is able to pan through 170° in the horizontal and 100° in the vertical. To hold panning speeds to an acceptable level (fast panning speeds give a very jerky look to the finished video), a dual servo slow unit is fitted between the fail-safes and the pan and tilt servos.

The fail-safes are fitted to serve as set-locks. If the transmitter is switched off in flight the camera will move to the pre-set position and sit absolutely still in order to further enhance the quality of the finished video. All of these refinements are fitted to give maximum flexibility combined with a rock-solid finished video.

Finally, the video receiver antenna; here only the best will do. As the airborne video transmitter is a low power unit, a very good antenna is required on the video receiver. We are currently using a 17dB hand-held Yagi, pointed at the aircraft by an assistant.

At the 2007 Challenge we used a dish and this gave much better range. As both the Yagi and dish antennas are very directional, aim is a tedious and somewhat boring task for any assistant and their minds often tend to wander! As a result there are occasionally blocks of scrambled video in the middle of the clip where the antenna drifts off target.

A better arrangement would be an auto tracking antenna or possibly an omnidirectional antenna such as a high gain collinear antenna. SC



Frame grab showing the definition possible with a good video system Silvertone recommend the best possible camera, despite the risk of total loss in a crash.

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MAKING 3D MOVIES

While there has been a lot of publicity around the latest introduction of 3D movies and the accompanying 3D screens and glasses, 3D movie production is very expensive. In fact, it comes as a surprise to most people to find that the blockbuster "Alice in Wonderland" was actually shot in conventional 2D and labouriously converted to 3D later! Now there is a new Australia camera rig, the SpeedWedge, which promises to streamline the whole process.

By BARRIE SMITH

The blockbuster "Avatar" set the new standard for 3D movies and film-goers have been very enthusiastic.

Part of its success is due to the very good 3D camera work but the bulk of the 3D cameras has been a major disadvantage. The set-ups demand that the paired cameras either employ prisms or partially reflecting mirrors to permit a controllable separation of the two lenses, to capture the left and right image pairs.

The average human eye separation is around 65mm, so image capture is best served by the camera lens' interocular distance (IOD) set at about 70mm for most subject material. For close-ups, a smaller IOD is preferred.

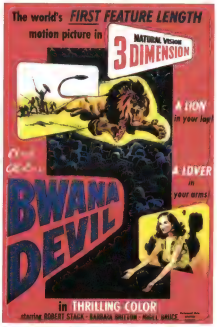
In "Dial M for Murder", often recognised as one of the best of the 1950s' 3D movies, Director Alfred Hitchock was forced to use a large and inflexible camera rig. In one key dramatic scene he used a scaled up telephone to provide an extreme close-up. The reason: it was physically impossible to rig the lenses to give a closer IOD.

A recent Australian innovation, the SpeedWedge, could make things much easier. It was developed by physicist and stereographer Leonard Coster. The rig consists of a housing that holds a pair of gen-locked Silicon Imaging SI-3D digital cameras. One camera is placed on top, its lens pointing downwards and aimed onto a partially-silvered mirror with 50% reflectance. This camera captures the left eye image.

Beneath it is another, matching camera installed horizontally within the rig, its lens pointing ahead and looking through the same partially-silvered mirror. This camera captures the right eye image. The complete rig is mounted onto a television camera tracking pedestal.

Fig.1 shows the general concept. The partially silvered mirror is the key, with each camera receiving half the light from the scene. By having the cameras mounted at rightangles to each other, their effective lens separation can be varied from zero to as wide as is desired, without any mechanical interference between them.

In practice, if the scene involves action in the foreground, the IOD is set to a small value. Conversely, if the scene or subject is more distant, the IOD is set to a large value. While any video cameras could have been used in the SpeedWedge, the Silicon Imaging cameras were chosen because they use the SiliconDVR recording software which solves a major post production problem.



Bwana Devil is a 1952 drama based on the true story of the Tsavo maneaters. It started the 3-D boom in the US film-making industry from 1952 to 1954.

Realising that the 3D camera setup would not capture macro shots, Director Alfred Hitchcock organised a scaled-up phone for a key scene in the 1950s movie "Dial M for Murder".

SiliconDVR records the two camera data streams in one go so, in terms of the capture workflow, a major task is handled elegantly. As Coster says: "If you can't synchronise your cameras and record the two data streams eas-

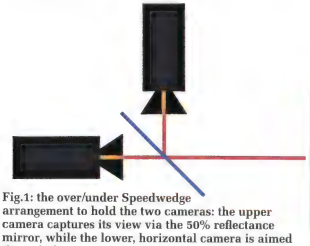


Fig.1: the over/under Speedwedge arrangement to hold the two cameras: the upper camera captures its view via the 50% reflectance mirror, while the lower, horizontal camera is aimed through the mirror's 50% reflective surface.

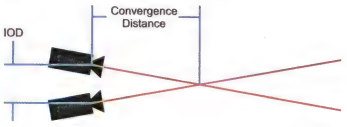


Fig.2: the IOD is the distance between the axes of the two lenses and the convergence distance is the distance from the camera to the object they are both pointing at. Some people also refer to this as the convergence angle, which is the angle between these two axes.

ily on set, you're in a lot of trouble!"

The SI camera heads have a significant advantage with their small size. This leads to a complete rig that can be picked up by one person. If you wanted to strap two big film cameras into the housing, you could do it but the weight and final size would be impractical for hand-held operation.

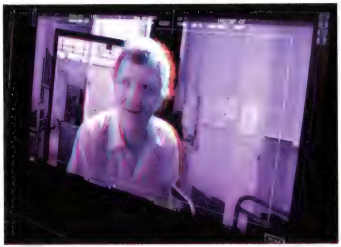
In practice, the Speedwedge rig allows the IOD (inter-ocular distance) to be varied from zero (for macro shots) to 70mm, covering mid-range and telephoto shots. In practice, the IOD needs to be set differently for each and every scene and the actual setting depends on how strong the director wants the 3D effect to be.

This leads to a further consideration. If a wide angle or telephoto lens is to be used in 3D shooting, what it does to the apparent depth in the scene has to be taken into account .Telephoto lenses tend to fight the 3D effect because, even in 2D photography, a telephoto lens gives a fore-shortening or flattening effect. Hence, the perception of depth is quite poor with a telephoto shot.

Leonard Coster says it is much the same in 3D shooting: "We can try and push a little bit of apparent depth back into it by increasing the interocular separation. However, you have to be very careful that you don't produce too large an offset in those images' background and foreground divergences on screen — otherwise you make the vision too hard for your viewers."

He stresses "we're not producing a perfect reproduction of the real world because we may not be using the same size sensor and a standard focal length lens or 'normal' IOD, but I want to give the audience a comfortable stereo

Leonard Coster the and beam-splitting camera rig.



On-set checking of the stereo effect can be made with a display set up as an anaglyph (red/cyan) picture or with a cross-polarised monitor, viewed through appropriate specs.

The Speedwedge rig used on another recent production, also photographed by DOP Tom Gleeson and directed by Tahnee McGuire.

image that is immersive and visceral without causing eye strain."

Data handling

As already noted, the SI-2K cameras' data streams are recorded to two hard drives. Coster adds that if you're using other broadcast cameras, the data may go to flash memory cards or a hard drive; if you're using 35mm film cameras it goes onto two film rolls.

On-set monitoring can be accomplished by using a video display, with the pair of left/right images shown on screen as an anaglyph (red/cyan) image. It is viewed through the familiar red/cyan specs, just as you would a 3D movie.

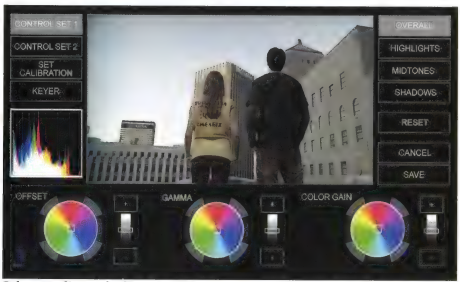
Alternatively, you can use small cross-polarised monitors which take two colour signals and give you, with polarising glasses, full colour stereoscopic viewing.

For post production, you still edit, Coster explains, just as you normally would, with two streams of vision for every scene. You can merge these two separate data streams later, then have a file which represents a single series of frames, in which there are a myriad of post production paths.

It's even possible to create a stereo DCP (Digital Cinema Package) file that allows you to deliver a hard drive to any DCP-compliant cinema in the world. The cinema operator can load it into the server and play back the 3D vision through the house projectors.

In the post-production process, overall colour corrections and convergence can be adjusted. The latter process involves off-setting the two images right or left relative to each other.

What this effectively does is rack the entire set back and forth, determining what the audience will see at the screen plane.



Colour grading and adjustment of convergence can be made post shooting, thanks to Silicon Imaging's software.

The shoot

Producer-Director Bernie Zelvis was asked by SMPTE Sydney in 2009

Converting 'Flatties' to 'Deepies'

It may come as a surprise to some to find Tim Burton's spectacular 3D movie "Alice in Wonderland" was not originally shot in 3D but photographed in 2D. The same applies to "Clash of the Titans".

Hollywood producers are now looking through their back catalogs to find suitable titles that can be converted from 2D to 3D, to cash in on the current fervour for 3D titles.

The last two Harry Potter films are likely candidates as are classics, such as early Star Wars, Titanic and other major titles.

The result is not always a perfect transformation: many viewers who saw Clash were, to say the least, unimpressed, with one blogger claiming the film was "flawed in so many ways, not least because of its underwhelming visual appeal, its lack of '3Dness' but also because the story is just as flat as the visuals." The "Clash" conversion is reputed to have taken 10 weeks to perform at a cost of around $US4.5 million.

The US company involved was Prime Focus who developed the software and employed an Indian facility to do the actual leg work.

How is it done?

A process called rotoscoping is at the heart of it: using part manual and part Computer-Generated Imagery (CGI) processes, an operator hand traces the main elements in each scene, so separating them and allowing each object to be tracked and "converted" to produce the second eye's view. This of course can be extremely complex, depending on the scene.

The first step is to separate the shot into somewhere between two and eight layers of depth. One example may be an image of a person standing in front of a building, with a blue sky and clouds behind. The operator can separate this shot into three layers: the person, the building and the sky with clouds.

Contour lines are then drawn around objects in each layer and a topographic layout created with depth lines to indicate the position of each object in the stereo window.

Naturally, the objects might well be moving in the succession of frames: computer software can track this movement and create 'in-between' frames, so avoiding the laborious effort of tracing each frame. The software also assesses and inserts detail that may be behind each moving object.

At this point you have a collection of objects that may look like cardboard cutouts situated at different depth planes. To 'round them out', texture maps are taken from each object and overlaid on the shapes. This will give each character facial depth, costume detail, etc.

Coster remarks: "It's a lot of work. Ultimately, it can produce very good results but it is not as good as shooting in 3D. However, you do end up with a movie asset of far more value."

In Hollywood, the dollar speaks loudly.

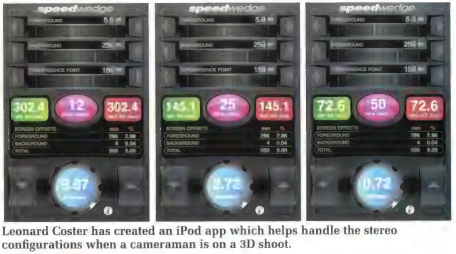
to produce a 3D short for its Dimensionale 3D film festival. To do it, he called on Leonard Coster to supply his new 3D rig to be used by Director of Photography (DOP) Tom Gleeson. The result was *Highly Strung*, with a running time of two minutes.

Tom Gleeson admits that, like many, he had a dim view of 3D "based on cheezy movies and red/blue paper glasses." Then, for the first time, he viewed an HD film on a 3D cross-polarised monitor: "I was at first astounded and then converted. HD and 3D are a potent mix."

In his view a large part of a DOP's job is to create a sense of depth in 2D images using lighting, lenses and composition. When confronted with images that actually have depth there needs to be a rethink!

He says that, after a lifetime watching, analysing and creating 2D, it can be confronting when the paradigm shifts. Once immersed in 3D shooting you have powerful new tools like IOD and convergence that control this new depth.

Gleeson recalled that the footage looked "amazing, with depth that felt like you could walk into it." On one occasion he used smoke to enhance the lighting in the shots and to help create a sense of volume. He feels 3D can immerse a viewer within a picture and story like no other format can.



Leonard Coster has created an iPod app which helps handle the stereo configurations when a cameraman is on a 3D shoot.

To convey and enhance the depth in each shot he kept the camera movements fluid, with long tracking shots. The cameraman must also give consideration to editing: fast cutting 3D shots can be challenging for viewers, so longer and wider tracking shots are often more suitable. Cutting points also need to be thought out, as parameters such as convergence and IOD should not jar.

3D Drama

Although the SMPTE short was Bernie Zelvis' first foray into 3D stereoscope production, he currently finds himself writing a TV drama series specifically for 3D.

From the exercise, he discovered the 3D viewing experience can be easily 'broken' by trying to squeeze too much space range onto the picture and ends up hurting the eyes.

He concludes there are "traps for young players". In his opinion, a stereographer like Leonard Coster is necessary to keep you from trying things that just won't work, as well as to supervise the post process.

"The biggest plus with the system we were using was that completed shots could be projected onto a screen, only minutes after the shoot: This impressed all who saw it. One TV executive said this wasn't even on their radar... it is now!" SC

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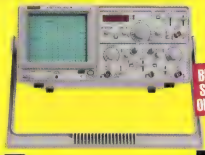

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Outdoor Camera

Easy to install weather-resistant security camera that's ideal for outdoor use. Can be connected directly to your TV for constant monitoring or DVR for recording footage. L6194 **NOT CARRIED IN ALL STORES BUT CAN BE ORDERED IN.**

$249

Swann

LCD Securaview 1 Camera Kit

Low cost and affordable, easily DIY installable security monitoring system including a 7" LCD colour monitor and single camera (expandable up to 3 cameras), with 60ft (18m) cable, power adaptor and theft deterrent stickers. L6189 **NOT CARRIED IN ALL STORES BUT CAN BE ORDERED IN.**

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Dick Smith 100g Lead-Free Solder Roll

A lead-free 1.0mm solder alloy containing flux for general electronics work where earlier lead-based solders cannot be used. This solder is 99.3% tin and 0.7% copper. Recommended for use with iron-clad or nickel-clad soldering iron tips. 100g roll. N2630

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Great value digital multimeter with 4000 count LCD screen. Includes Capacitance, Frequency, Duty Cycle and Temperature measurement functions. Includes K-type temperature probe, test leads, and protective holster. Q1456 **NOT CARRIED IN ALL STORES BUT CAN BE ORDERED IN.**

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Lightweight handle with burn-resistant cable, 45W power, 250°C to 450°C temp range, 240V powered, with 1.6mm tip and cleaning sponge. T1976

GEAR 2 GO

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Mini Spy Camera

Only 5.5cm tall by 2cm wide. Clip it on to your clothes, use for surveillance, or as a webcam. Solidly built casing, comes with 2GB micro SD card (expandable to 8GB) and rechargeable Li-Ion battery. L8401

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Dick Smith Air Speed and Temp Meter
A highly accurate air speed and temperature meter producing an easy-to-read digital temperature display in Celsius and Fahrenheit. Air speed in metres per second, kilometres per hour, knots, feet per minute and miles per hour. Also measures the average air velocity from multiple locations (up to 8) and single point average airflow, which is ideal for servicing air conditioning systems. Q1302

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CLEARANCE! STRICTLY LIMITED STORE STOCK ONLY

Dick Smith 100W Professional Soldering Station
Ideal for lead-free soldering, this solidly built station with all-metal chassis provides adjustable temperature from 200 - 450°C. Energy Saver circuitry, huge 100W power for fast heat-up and recovery, ESD safe design, maintains tip temperature within +/- 3°C, and includes a 1.6mm tip plus soldering iron holder. 2 year warranty. T2260 **STORE STOCK ONLY, NO WEB OR MAILORDER SALES.**

$99 SAVE $100

digitor
Cable Coax 75 Ohm RG6 20m
Upgrade your TV antenna system with this quality dual shield coaxial cable. Perfect for digital TV, pay TV, satellite TV and analog TV, ideal for low signal areas. W2075

$19.88 SAVE $20

PRO-70K Butane Solderpro Kit
Cordless, quick ignition, 70W butane-powered soldering iron kit, includes 3mm soldering tip, plus hot knife, heat blower, and blow-torch tips as well as solder and a tip cleaning sponge, all stored in a handy carry case. T1108 **NOT CARRIED IN ALL STORES BUT CAN BE ORDERED IN.**

$49.98 SAVE $20

digitor
450pc Ratchet Crimper Kit
This 450pc terminal kit includes a very solidly built professional ratchet crimper and 18 different styles of quality terminals in a handy component case. Terminal types include Ring, Fork, Butt and Tab styles. See www.dicksmith.com.au for a complete list of the included terminals. H5802

$49.99 SAVE $20

High-Quality Test Lead Set with Alligator Clips
Fully shrouded right angle meter plugs, 1.1m cables, 100mm handle with threaded 1.5mm probe-end, and supplied with threaded alligator clips. Q1920

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LIMITED STOCK. ONLY 200 AVAILABLE!

Sealed Polycarbonate Box
Made from tough polycarbonate thermoplastic, with a tongue and groove sealing system and stainless steel lid-fixing screws that thread into brass inserts. Measures 171x121x80mm. H2867
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$9.88 SAVE $10

4-Way Metal Powerboard
Surge and overload protected powerboard with a heavy duty metal casing, RFI/EMI noise filtering, an illuminated master on/off switch, and a spaced mains outlet for larger AC adaptors. Provides 575 Joule surge absorption rating. M7357

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Anti-Static Solder Sucker
Easy-to-clean solder sucker with a strong metal body, excellent suction and a heat-resistant Teflon tip. T2567

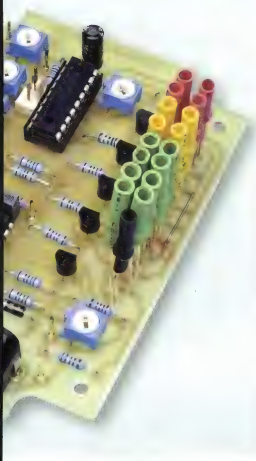
$6.88 SAVE $6

By JOHN CLARKE

Unflued gas heaters are a hazard to health & life . . .

Build an Air Quality Monitor to ensure your safety & well-being

This Air Quality Monitor indicates carbon dioxide (CO_2) and carbon monoxide (CO) levels on a dual bargraph and sounds an alarm when either level reaches a preset concentration. You should use it if you have an unflued heater in your home, boat, caravan or any indoor space.



Main Features & Specifications

Features

- Detects carbon monoxide (CO) and carbon dioxide (CO_2) levels
- 15-level LED bargraph display for each gas
- Three-stage alarm ranging from initial warning through to urgent
- Internal fan replenishes air for sensors
- Automatic display dimming in low light levels

Specifications

CO_2 Range: 0.03% to 1% (300-10,000ppm) with recommended calibration.

CO Range: .003% to .03% (30-300ppm) with recommended calibration.

Bargraph Displays: separate bargraphs to show CO and CO_2 concentrations, each consisting of eight LEDs with 15 display levels.

Alarm Modes: 16ms chirp every 16s (third top LED), 32ms chirp every 4s (second top LED) and 64ms chirp every 0.5s (top LED).

CO_2 Sensor Heating: continuous at 200mA.

CO Sensor Heating: 60s heating at 150mA; 90s reading period at 42mA.

Readings Update: CO = 2.5 minutes; CO_2 = after an initial 60s then with a nominal 5s lag due to sensor response.

Dimming Range: 205 brightness levels.

Diagnostic Display: CO sensor only when VR4 is set to give 0V on TP4. The top two LEDs are lit during the heating cycle, while the third top LED and LEDs below light for the measurement cycle with these LEDs extinguishing successively every 15s.

Power Supply: 12VDC 500mA plugpack.

ALL COMBUSTION heaters, including those using wood, coal, coke, kerosene, methylated spirits and gas, draw oxygen from the air as the fuel is burnt. If used indoors, such as inside a house, this gradually reduces the oxygen concentration in the air unless there is sufficient ventilation to the outside. However, judging how much room ventilation is needed to keep the air safe is almost impossible and it's all too easy to provide insufficient outside air. After all, you do want to keep warm.

If you don't have sufficient fresh air in the room, there is the immediate danger that the deadly gas carbon monoxide will be produced. This is much more likely if the heater is unflued, whereby the combustion gases are released into the room. Unfortunately, most gas heaters used in Australia are unflued and every one of these is a potential source of carbon monoxide and other noxious gases.

Some gas heater designs attempt to get around this problem by employing an oxygen depletion sensor. These extinguish the heater if the oxygen concentration in the room is reduced by 20%. While better than having no sensor at all, this definitely should not be regarded as a safe answer. Why? Because regardless of whether the oxygen depletion sensor, a pretty crude device, is working, the heater may still produce some carbon monoxide as well as the normal combustion products of carbon dioxide, water vapour, nitrogen oxides, sulphur dioxide and formaldehydes.

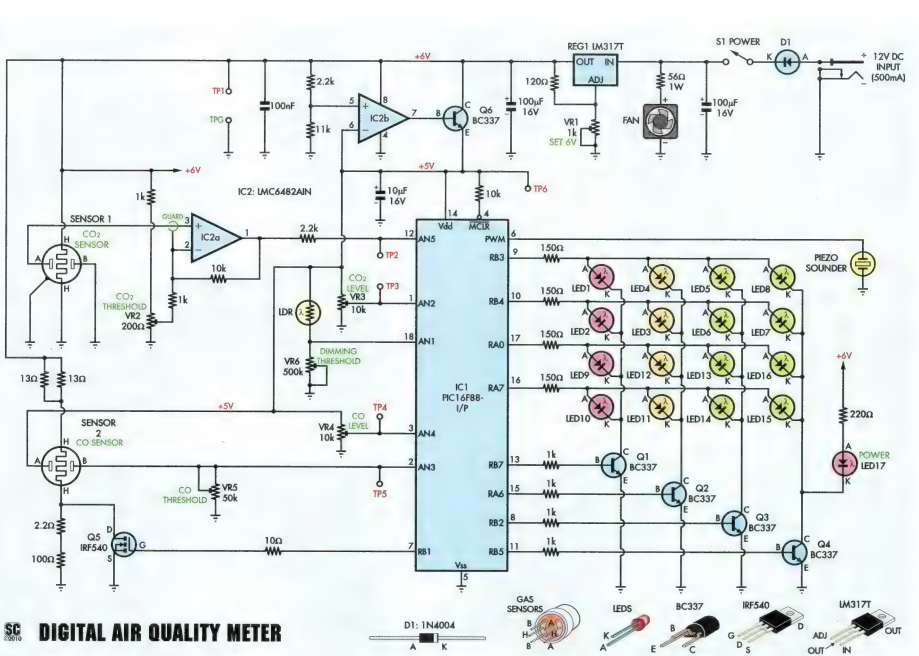
An oxygen depletion sensor does not detect or react to any of these noxious and potentially harmful gases – it only detects a reduction in oxygen concentration.

Even if no carbon monoxide is produced, all unflued gas heaters still produce the other combustion products listed above and these can cause breathing difficulties for people who suffer from asthma or allergies. Ultimately, unflued gas heaters must be regarded as less than ideal but they are much cheaper than properly flued gas heaters and most of them have the advantage of using a bayonet gas connector which allows them to be moved from room to room.

Monitoring air quality

Ideally, if you have a combustion heater in your home, there should be some means of monitoring the air quality. The SILICON CHIP Air Quality Monitor measures both carbon dioxide and carbon monoxide levels and displays the results on LED bargraphs. If the concentration of either of these gases rises above a preset level, a loud alarm will sound which means that you should turn off the heater and open the room up to fresh air.

Each bargraph comprises eight LEDs that light individually (ie, one at a time) to show eight distinct levels. In-between values are displayed by lighting two adjacent LEDs. This



DIGITAL AIR QUALITY METER

Fig.1: the circuit is based on two gas sensors (Sensor 1 for CO_2 and Sensor 2 for CO) plus a PIC16F88-I/P microcontroller (IC1). IC1 in turn drives a 4 x 4 LED matrix array, with the LEDs arranged to form two bargraphs. IC2b & Q6 provide a +5V rail for IC1.

gives a total of 15 levels that can be displayed. The four lower LEDs are green, followed by two orange and then two red LEDs. An automatic dimming circuit ensures that the LED displays are not too bright at night.

In addition, the alarm sounds if any of the top three LEDs light in either display. There are three alarm levels: (1) a main alarm that sounds if the top LED lights. This consists of a 64ms-long 4kHz tone that repeats every 0.5s; (2) a less urgent alarm that sounds if the second top LED is lit (top LED off). This alarm gives a 32ms-long 4kHz "chip" every four seconds (4s); and (3) a warning alarm that sounds if the third top LED is alight. This alarm mode gives a brief 16ms 4kHz "chirp" every 16 seconds (16s).

As shown in the photos, the Air Quality Monitor is housed in a plastic case with a clear lid to reveal the LED bargraphs. An internal fan at one end draws air through the box so that the internally-mounted CO and CO_2 sensors are presented with a continuous sample of the air that's being monitored. Power for the unit comes from a 12VDC 500mA plugpack.

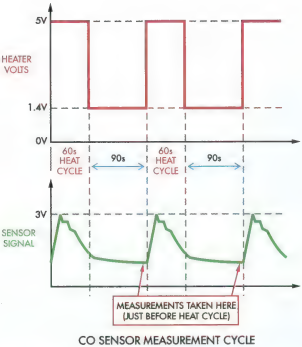


Fig.2: this diagram shows the measurement cycle for the CO sensor. The sensor is initially heated using a 5V supply for 60s, then the heater voltage is reduced to 1.4V for 90s. The CO concentration is measured near the end of this 90s period, after which the heating cycle is repeated.

Circuit details

Take a look now at the circuit of Fig.1. It's based on two gas sensors and a PIC microcontroller (IC1). The microcontroller monitors the sensor signals and drives two multiplexed LED bargraph displays.

We'll start by looking at the CO_2 sensor. This consists of a heater coil and a solid electrolyte cell comprising a lithium (Li) cathode and a potassium (Ka) anode. When these electrodes react with carbon dioxide, a potential difference is produced between them that varies with the CO_2 concentration.

The sensor is built into a metal housing and is exposed to air (and to CO_2) via a stainless steel mesh. Its output in normal air (ie, with a normal CO_2 concentration) is typically 325mV. This voltage falls with increased CO_2 concentrations beyond 400ppm (parts per million) or 0.04%.

The CO_2 concentration in normal air is 0.0314% but this can increase to 5% in air that's directly exhaled from the lungs. At this latter level, the sensor's output will be well below 250mV (compared to 325mV in standard air).

The CO_2 sensor's output appears across its "A" and "B" terminals and has a very high impedance, so any loading will drastically reduce this output. As a result, the manufacturer recommends monitoring the voltage using a circuit that has a 100GΩ to 10TΩ input impedance and an input current not exceeding 1pA.

To comply with these requirements, we have used an LMC6482 CMOS op amp (IC2a) to buffer the sensor signal. Its input impedance is 10TΩ while the input current is typically just 0.02pA.

Note, however, that these specifications would not normally be met when the op amp and the sensor are mounted on a PC board, due to leakage current. Fortunately, this leakage current can be prevented by shielding the sensor's output pin and the op amp's pin 3 input with a complete loop of copper track.

As shown, this loop is connected to the op amp's pin 2 inverting input. Because the inverting input is at the same potential as the non-inverting input, no current flows between them and the shield (or guard) track prevents any leakage between pin 3 and other sections of the PC board.

IC2a is wired as a non-inverting stage with a gain of about 11, as set by the 10kΩ and 1kΩ feedback resistors. As a result, a 315mV output from the sensor (ie, in normal air) should result in a 3.47V output from the op amp.

In practice, we found that the output from the particular CO_2 sensor we used was greater than 315mV in normal air, causing IC2a's output to go above 5V. Consequently, trimpot VR2 has been added so that IC2a's output can be level shifted, to correctly set the output to 3.47V in normal air.

Note that VR2 changes IC2a's gain slightly, depending on its setting, but this doesn't matter in this application.

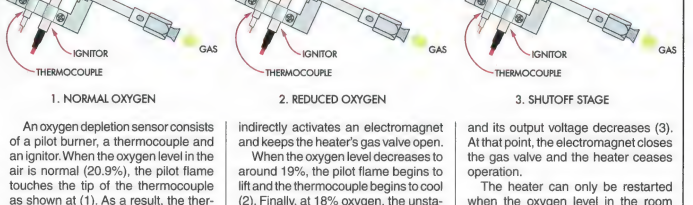
In practice, VR2 is adjusted so that the lowest LED in the CO_2 bargraph is just off in normal air. By contrast, the maximum bargraph level is adjusted using VR3 which sets the voltage on the AN2 (pin 1) input of IC1. This voltage is used by IC1 to calculate the display levels.

The amplified sensor signal at the output of IC2a is applied to the AN5 (pin 12) input of IC1 via a 2.2kΩ resistor. An internal analog-to-digital (A/D) converter then converts the signal to a digital output to drive the bargraph display.

Note that the output from the sensor is valid only after it has been heated sufficiently. This is achieved by connecting a 6V supply across the internal heater element.

For this reason, the microcontroller

How an Oxygen Depletion Sensor (ODS) Works



An oxygen depletion sensor consists of a pilot burner, a thermocouple and an ignitor. When the oxygen level in the air is normal (20.9%), the pilot flame touches the tip of the thermocouple as shown at (1). As a result, the thermocouple generates a voltage which indirectly activates an electromagnet and keeps the heater's gas valve open.

When the oxygen level decreases to around 19%, the pilot flame begins to lift and the thermocouple begins to cool (2). Finally, at 18% oxygen, the unstable pilot flame lifts off the thermocouple and its output voltage decreases (3). At that point, the electromagnet closes the gas valve and the heater ceases operation.

The heater can only be restarted when the oxygen level in the room returns to normal.

The Effects Of CO And CO_2

Carbon monoxide (CO) is a colourless, odourless gas that's made up of molecules comprising one carbon (C) atom and one oxygen (O) atom. By contrast, carbon dioxide (CO_2) molecules consist of one carbon and two oxygen atoms. Over time, CO molecules will pair with a spare oxygen atom to form the more stable carbon dioxide (CO_2) gas.

CO_2 has a concentration of about 0.03% in fresh air and is not dangerous at such low levels. However, higher concentrations result in accelerated breathing and an increase in heart rate and can lead to headaches and dizziness. And a concentration of 10% can cause respiratory failure and death within a matter of minutes.

CO_2 concentrations can increase in enclosed spaces when oxygen is combined with carbon to form CO_2, due to combustion and respiration. High CO_2 concentrations are a sure sign that oxygen has been depleted from the air and this can heighten the adverse effects of elevated CO_2 levels.

Poor combustion can result in the production of the oxygen-starved carbon monoxide (CO) gas. Carbon monoxide is extremely dangerous because it has a 200 times greater affinity for haemoglobin than does oxygen. As a result, it blocks oxygen from being carried by the blood supply to other parts of the body, including the brain.

Table 3 list the physiological effects of various concentrations of carbon monoxide in air. As can be seen, even relatively low concentrations can be dangerous.

Table 3: Physiological Effects Of CO

Concentration	Symptoms
0.005% (50ppm)	No symptoms with prolonged exposure.
0.01% (100ppm)	Slight headache within a few hours.
0.05% (500ppm)	Headache within 1 hour, increasing in severity over time.
0.1% (1000ppm)	Headache, dizziness and nausea within 20-30 minutes; death within two hours
0.4% (4000ppm)	Headache, dizziness and nausea within 5-10 minutes; death within 30 minutes
1% (10,000ppm)	Death in 1-3 minutes

ignores readings from this sensor for the first 60s after power is applied.

CO sensor

The output from the CO sensor (Sensor 2) is monitored at the AN3 input (pin 2) of IC1. However, this sensor operates differently from the CO_2 sensor in that it varies its resistance with CO concentration.

The sensor itself is made up of a tin dioxide layer deposited onto an aluminium oxide ceramic tube. This tube is fitted inside a plastic housing and is exposed to air (and CO) via a stainless steel mesh.

The specifications state that this sensor must initially be heated using a 5V supply connected across its heater element for 60s. The heater current is then reduced by placing just 1.4V across the element for a 90s period. The CO concentration is then measured, after which the initial 60s heating cycle begins again – see Fig.2.

In practice, this means that measurements are repeated at 2½ minute (150s) intervals.

In our circuit, the heater is powered from a +6V rail via two parallel 13Ω resistors (equivalent to 6.5Ω), while Mosfet Q5 ties the lower end of the heater element to 0V. The heater has a resistance of 33Ω, so when Q1 is on, a current of 152mA flows through it. This results in a 1V drop across the two 13Ω resistors, thus giving the required 5V supply for the heater.

Q5 is controlled by IC1's RB1 output

and turns on when its gate is pulled high. In operation, RB1 switches Q5 on for 60s to provide the heating current. RB1 then goes low for 90s and this switches Q5 off so that the measurement can be made.

During this 90s period (ie, with Q5 off), the CO sensor's heater is effectively in series with the 2.2Ω and 100Ω resistors connected across Q5. As a result, the current through the sensor drops to 42.34mA which means that the voltage across the heater is now 1.397V (ie, 33 x 0.4234). That is close enough for practical purposes to the 1.4V value specified.

As before, the sensor's output appears across its A and B terminals. This output varies in resistance according to CO concentration, so one side is connected to the +5V rail and the other side to 0V via trimpot VR5 to form a voltage divider.

As a result, any changes in the sensor's resistance (ie, due to CO variations) will result in a corresponding voltage change at the top of VR5. This signal is then applied to the AN3 input of IC1 (pin 2) and fed to its internal A/D converter.

During set-up, VR5 is set so that AN3 is at 0.5V when the sensor is in normal air. However, this signal voltage can rise to around 3V when the CO concentration is over 300ppm.

In operation, the sensor varies its resistance over a 10:1 range for CO concentrations ranging from 10ppm to 1000ppm.

The maximum bargraph level for CO is adjusted using trimpot VR4. It effectively forms a voltage divider across the 5V supply and its output is applied to the AN4 (pin 3) input of IC1. This voltage, along with the sensor voltage on AN3, is then used by IC1 to calculate the bargraph display level.

Bargraphs

Two 8-LED bargraphs are used to indicate the CO_2 and CO levels and these are driven via eight outputs from IC1. These 16 LEDs (LED1-16) are wired in a 4 x 4 matrix, with transistors Q1-Q4 driving their common cathode connections. Q1-Q4 are in turn driven by the RB7, RA6, RB2 & RB5 outputs of IC1 via 1kΩ resistors.

In greater detail, transistor Q1 drives the cathodes of LED1, LED2, LED9 & LED10, while their anodes are respectively driven via the RB3, RB4, RA0 & RA7 outputs via 150Ω limiting resistors. Similarly, Q2 drives the cathodes of the second LED column in the matrix, Q3 the third column cathodes and Q4 the fourth column cathodes.

In operation, the LED bargraphs are controlled in multiplexed fashion, with the transistors switched on one at time in turn. This allows the LEDs in a switched column to be lit individually.

For example, when Q1 is switched on, either LED1, LED2, LED9 or LED10 can be switched on. This is done by taking either RB3, RB4, RA0 or RA7 of IC1 high. Alternatively, by taking more than one of these outputs high, the LEDs can be switched on in any combination.

The same goes for the other columns

Parts List

1 PC board, code 04306101, 104 x 78mm
1 IP65 ABS box with clear lid, 115 x 90 x 55mm (Jaycar HB-6246 or equivalent)
1 front panel label, 84 x 80mm, printed onto clear plastic film (eg, overhead projector film)
1 CO sensor (Jaycar RS-5615 or equivalent)
1 CO_2 sensor (Jaycar RS-5600 or equivalent)
1 50kΩ LDR with >1MΩ dark resistance (Jaycar RD-3480 or equivalent)
1 12V DC 500mA plugpack
1 12V cooling fan, 40 x 40 x 10mm
1 piezo transducer, 30mm diameter
1 2.5mm PC-mount DC socket (CON1)
1 SPDT PC-mount miniature toggle switch (Altronics S1421 or equivalent) (S1)
1 2-way screw terminal block, 5.08mm pin spacing (CON2)
1 2-way male pin header, 2.54mm pin spacing
1 2-way female pin header, 2.54mm pin spacing
1 DIP18 IC socket
1 mini TO-220 heatsink, 19 x 19 x 9.5mm
2 M4 x 12mm countersunk (CSK) screws (to secure fan)
2 M3 x 10mm countersunk screws (to secure piezo transducer)
1 6mm ID (internal diameter) Nylon washer (spacer for piezo transducer)
4 M3 x 6mm screws
1 M3 x 10mm screw
1 M3 nut
1 60mm length of 0.7mm tinned copper wire
8 PC stakes
1 340mm length of black 5mm heatshrink tubing; OR
1 160mm length of 5mm green heatshrink tubing, 1 80mm length of 5mm yellow heatshrink tubing & 1 100mm length of 5mm red heatshrink tubing (to match LED colours)

Semiconductors

1 PIC16F88-I/P microcontroller programmed with 0430610A.hex (IC1)
1 LMC6482AIN dual op amp (IC2)
5 BC337 transistors (Q1-Q4, Q6)
1 IRF540-N channel Mosfet (Q5)
1 LM317T adjustable regulator (REG1)
1 1N4004 1A diode (D1)
5 3mm red LEDs (LEDs1-2, LEDs9-10, LED17)
4 3mm orange LEDs (LEDs3-4, LEDs11-12)
8 3mm green LEDs (LEDs5-8, LEDs13-16)

Capacitors

2 100µF 16V
1 10µF 16V
1 100nF MKT (code 100n or 104)

Resistors (0.25W 1%)

1 11kΩ	1 120Ω
2 10kΩ	1 100Ω
2 2.2kΩ	1 56Ω 5% 1W
6 1kΩ	2 13Ω
1 220Ω	1 10Ω
4 150Ω	1 2.2Ω 5%

Trimpots

1 500kΩ miniature horizontal trimpot (code 504) (VR6)
1 50kΩ miniature horizontal trimpot (code 503) (VR5)
2 10kΩ miniature horizontal trimpot (code 103) (VR3,VR4)
1 1kΩ miniature horizontal trimpot (code 102) (VR1)
1 200Ω miniature horizontal trimpot (code 201) (VR2)

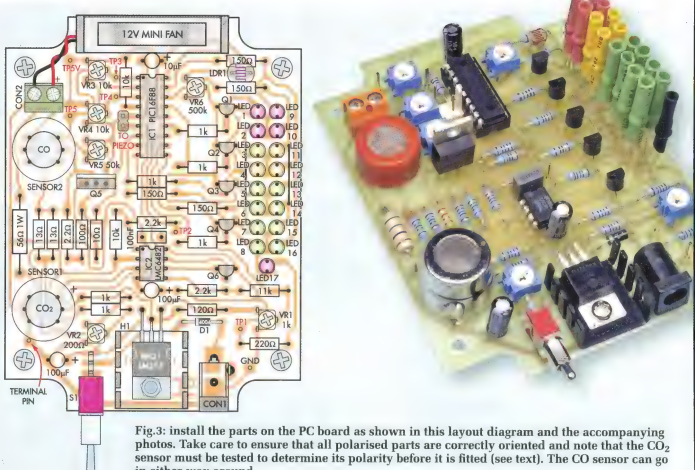


Fig.3: install the parts on the PC board as shown in this layout diagram and the accompanying photos. Take care to ensure that all polarised parts are correctly oriented and note that the CO_2 sensor must be tested to determine its polarity before it is fitted (see text). The CO sensor can go in either way around.

in the matrix when their switching transistor is on.

Each transistor is driven on for about 1ms before switching off. As soon as it switches off, the next transistor is switched on to drive the next column of LEDs. However, there is a short gap (or "dead time") between one transistor switching off and the other switching on, to prevent display errors.

In operation, the LEDs are switched on and off at such a fast rate that they appear to be continuously lit. They are also physically laid out on the PC board as two bargraph columns. The top two rows of LEDs in the matrix (LEDs1-8) form the CO bargraph, while the bottom two rows (LEDs9-16) form the CO_2 bargraph.

LED17 is the power indication LED. This connects to the +6V supply via a 220Ω current-limiting resistor and is driven by transistor Q4, so that it always appears lit when power is applied.

Display dimming

Automatic display dimming is achieved using a light dependent resistor (LDR). As shown, the LDR is connected in series with trimpot VR6 across the 5V supply to form a voltage divider. The output of this voltage divider is connected to the AN1 input (pin 18) of IC1.

In bright light, the LDR's resistance is 50kΩ or less and so the voltage applied to IC1's AN1 input is pulled close to the 5V supply. This signals IC1 to drive the LEDs at full brightness.

Conversely, at lower ambient light levels, the LDR's resistance increases and voltage at AN1 decreases. As a result, IC1 now drives the LEDs with a reduced duty cycle. This is achieved by using a longer dead time, ie, the time between when one transistor switches off and the next one switches on. This effectively reduces the length of time that the LEDs are lit and hence reduces their brightness.

In full darkness, the LDR has a high resistance and VR6 pulls the AN1 voltage down close to 0V. The display is then dimmed to its maximum extent.

Piezo alarm

The alarm feature is provided by using the pin 6 PWM (pulse width modulation) output of IC1 to drive a piezo transducer. Its frequency of operation is set to 4kHz (50% duty cycle) and there are three alarm modes, as described earlier.

Note that the alarm is only activated when one of the top three LEDs in either bargraph is lit.

Power supply

Power for the circuit is derived from a 12VDC 500mA plugpack, with diode D1 providing reverse polarity protection. The nominal +12V supply rail is then fed via on/off switch S1 to the input of 3-terminal regulator REG1, with filtering provided by a 100µF 16V capacitor.

This +12V supply rail also drives a 12V fan via a 56Ω resistor. The resistor is there to reduce the fan speed and thus the noise it makes, while still allowing sufficient air to be drawn through the case.

REG1 is an LM317T variable regulator and is configured to provide a 6V supply. The voltage between its OUT and ADJUST pins is nominally 1.25V

Above: inside the completed prototype. Light pipes made from heatshrink sleeving are fitted to the bargraph & power LEDs.

but in practice can be anywhere from 1.2V to 1.3V.

If this voltage is 1.25V, this means that a current of 10.4mA flows through the 120Ω resistor and trimpot VR1. Adjusting VR1 to 456Ω sets the voltage across it to 4.75V and the output the regulator to 6V (ie, 4.75V + 1.25V). This 6V supply is used to drive the heaters in the CO_2 and CO sensors.

In addition, the 6V rail is fed to a voltage divider made up of 2.2kΩ and 11kΩ resistors. The resulting +5V output from the divider is then fed to the pin 5 (non-inverting) input of op amp IC2b which in turn drives current amplifier Q6 (BC337).

As shown, Q6's emitter provides feedback to IC2b's inverting input. As a result, IC2b automatically adjusts its output to maintain +5V at Q6's emitter. This +5V rail powers microcontroller IC1, trimpots VR3 & VR4 and LDR1.

Construction

Construction is a snap with all parts, except the 12V fan and piezo alarm, mounted on a PC board. This board is coded 04306101 (104 x 78mm) and is housed in a 115 x 90 x 55mm IP65 ABS box with a clear lid so that the LED bargraphs are visible.

The PC board is designed to mount onto integral standoffs within the box. Begin by checking that the PC board fits neatly inside this case. If not, carefully file the edges and/or file the corner cutouts until it does.

Next, check the PC board for breaks in the tracks or shorts between tracks and pads. Repair any defects as necessary (they are rare these days), then check that the hole sizes are correct by test fitting the larger parts (ie, the screw terminal block, regulator REG1, trimpots, sensors and the DC socket).

Check also that the regulator's mounting hole and the corner mounting holes are all 3mm in diameter.

Fig.3 shows the parts layout on the PC board. Start the assembly by fitting the two wire links and the resistors. The resistor colour codes are shown in Table 1 but you should also check each one with a digital multimeter, just to make sure.

Diode D1 is next on the list, taking care to install it with the orientation shown. Once it's in, install PC stakes at all the test points and adjacent to the CO_2 sensor, then install the 2-way pin header for the piezo transducer.

Next, install a DIP18 socket for microcontroller IC1, again taking

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	11kΩ	brown brown orange brown	brown brown black red brown
❑	2	10kΩ	brown black orange brown	brown black black red brown
❑	2	2.2kΩ	red red red brown	red red black brown brown
❑	6	1kΩ	brown black red brown	brown black black brown brown
❑	1	220Ω	red red brown brown	red red black black brown
❑	4	150Ω	brown green brown brown	brown green black black brown
❑	1	120Ω	brown red brown brown	brown red black black brown
❑	1	100Ω	brown black brown brown	brown black black black brown
❑	1	56Ω 1W 5%	green blue black gold	not applicable
❑	2	13Ω	brown orange black brown	brown orange black gold brown
❑	1	10Ω	brown black black brown	brown black black gold brown
❑	1	2.2Ω 5%	red red gold gold	not applicable

The fan is attached to one end of the case using two M4 x 12mm countersunk screws while the transducer is secured using M3 x 10mm countersunk Nylon screws – see text. Note the ventilation holes in front of the fan.

care to orient it correctly (ie, notch towards the top). By contrast, IC2 can be directly mounted on the PC board and this can go in next. It faces in the same direction as IC1.

The DC socket and the 2-way screw terminal block are next on the list. Be sure to mount the latter with its access holes facing outwards. Transistors Q1-Q4 & Q6 (all BC337) can then be installed.

Follow these parts with Mosfet Q5 (IRF540). This is mounted vertically with its metal tab towards trimpot VR5 and doesn't require a heatsink. By contrast, regulator REG1 mounts horizontally on the PC board and must be fitted with a small U-shaped heatsink for cooling.

CO_2 Sensor Orientation

The CO_2 sensor has a symmetrical pin arrangement and so will fit the PC board either way around. However, there's nothing on the package to indicate which output is the positive terminal.

This means that the sensor's output has to be checked before it is soldered in place on the PC board. Be sure to follow the step-by-step procedure in the text before fitting this device.

To install REG1, first bend its two outer leads down through 90° about 7mm from its body and the centre lead down through 90° about 4mm away. That done, fasten the regulator and its heatsink to the PC board using an M3 x 10mm screw and nut, then solder its leads.

Don't solder the regulator's leads before fastening it down. If you do, you could crack the copper tracks as the mounting screw is tightened.

Trimpots VR1-VR6 can now all go in. Be sure to use the correct value in each position.

Note that trimpots are often marked with a value code instead of their ohms value. In this case, the code markings will be 102 for the 1kΩ trimpot (VR1), 201 for the 200Ω trimpot (VR2), 103 for the 10kΩ trimpots (VR3 & VR4) and 503 for the 50kΩ trimpot (VR5).

Mounting the LEDs

LEDs1-17 must all be mounted so that their tops sit exactly 30mm above the PC board. The best way to do this is to cut a 25mm-wide thick cardboard spacer which can be slid between the leads of each LED – just push the LED all the way down onto the spacers before soldering its leads.

Take care to ensure that the LEDs are all correctly oriented (the anode lead is the longer of the two) and be sure to use the correct colour at each location – see Fig.3.

Completing the board

Switch S1, the DC socket (CON1), the LDR and the two sensors can now all be installed. Note that the LDR should be mounted with its top surface about 5mm above the PC board.

The CO sensor (Sensor2) in the red plastic housing can go in either way around. **By contrast, the CO_2 sensor (Sensor2), which is in the metal housing, must be tested for polarity before it is installed. The step-by-step procedure is as follows:**

(1) Connect short lengths of hook-up wire between each heater pin on the sensor (ie, the centre pin of each set of three pins) and the corresponding pad on the PC board (polarity not important).

(2) Plug the appropriate DC connector into the plugpack lead, so that the "+" marking on the connector plug aligns with the "+" marking on the connector socket.

(3) Adjust VR1 fully anticlockwise, then connect a digital multimeter between GND and TP1. Set the meter so that it can measure up to 6VDC.

(4) Connect the plugpack to the DC socket, switch on and adjust VR1 for a reading of 6V on the DMM. That done, check for +5V on TP6.

(5) Connect the multimeter to the A and B terminals of the CO_2 sensor. You should get a reading of 300-500mV. Identify which terminal is positive and mark it with a "+" sign.

(6) Switch off, disconnect the heater wiring and mount the CO_2 sensor on the PC board with the positive (+) side oriented as shown on Fig.3.

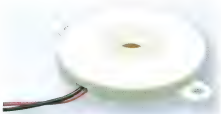
(7) Solder the PC stake adjacent to the CO_2 sensor to the sensor's body.

Fitting the microcontroller

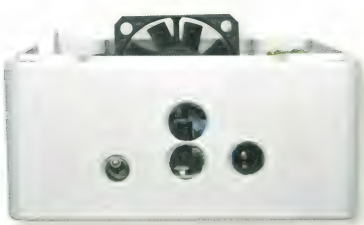
You can now fit the microcontroller (IC1) in its socket, taking care with the orientation. That done, apply power again and check that LED17 (the power LED) lights. If all is well so far, check that this LED dims when the LDR is covered over and adjust VR6 for best dimming results (note: adjustment of the dimming threshold is best done at night).

Initial adjustments

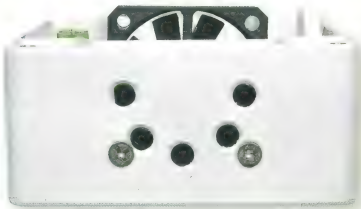
Before using the unit, it's necessary to adjust the full-scale sensitivity and threshold level of each bargraph



A 6mm ID Nylon washer is attached to the top of the transducer before it is installed in the case. This washer can be secured using a light smear of silicone sealant.



This view shows the power switch and DC socket end of the unit. The air to be monitored is drawn in through the two central holes.



The 12V fan blows the sampled air out through five holes at the other end of the case.

display. The initial procedure is as follows:

(1) Adjust trimpot VR3 (CO_2 level) to give 3V at TP3. This sets the CO_2 full scale sensitivity to about 10,000ppm or 1%.

(2) Adjust trimpot VR4 (CO level) to give 3V at TP4. This sets the full-scale CO sensitivity to about 300ppm.

Note: rotating trimpots VR3 & VR4 clockwise will increase the sensitivity of the CO_2 and CO bargraphs respectively (ie, the display will read higher for a given gas concentration). However, do not rotate VR3 for less than 2V at TP3 or VR4 for less than 2V at TP4.

Conversely, rotating each level trimpot anti-clockwise lowers the sensitivity of its corresponding bargraph.

(3) Adjust VR2 so that the bottom LED of the CO_2 bargraph just extinguishes (ie, no LEDs lit). This should be with TP2 at just under 3V.

(4) Wait 60s after applying power, then blow on the CO_2 sensor to expose it to extra CO_2 gas. Check that the CO_2 bargraph now shows a full-scale reading (ie, top LED lit). If the piezo transducer is connected, check that the alarm sounds with any of the top three LEDs lit.

CO sensor adjustments

Making the adjustments for the CO sensor is a slow process, since it requires a "burn-in" period of 48 hours. **The unit must therefore be left on for 48 hours before making the final adjustments.**

Additionally, as stated in the circuit description, the sensor is heated for 60s and then allowed to respond to the gas over a 90s period before each measurement is made. This means that it will take 2.5 minutes to get the result after each adjustment.

Initially, however, you can bypass the 48-hour burn-in period and make the initial adjustments straight away. The final "touch-up" adjustments can then be made after the burn-in period.

The first step it to adjust VR5 so that TP5 is at 0.5V right towards the end of the 90s measurement period, ie, when the sensor is in fresh air. However, this requires some means of monitoring the heating and measurement cycles. In practice, you can either use a second multimeter to monitor the drain of Q5 or use a diagnostic tool that's built into the Air Quality Monitor that shows the heating/measurement cycles.

The procedure for each method is as follows:

METHOD 1: if you have a second multimeter, connect it between Q5's tab (ie, its drain) and GND. Q5's tab will be close to 0V during the heating cycle and at 4.3V during the measurement cycle. Adjust VR5 to set TP5 to 0.5V near the end of the 90s measurement cycle.

METHOD 2: if using the inbuilt diagnostic tool, start by adjusting VR4 fully clockwise, so that TP4 is at 0V. This will now cause the CO bargraph display to show the heating and measurement cycle.

During the 60s heating cycle, the top two red LEDs will be lit. Then, during the 90s measurement cycle, the red LEDs switch off and the four green and two orange LEDs initially light. These LEDs then extinguish one at a time, starting with the topmost orange LED and continuing at 15s intervals until the bottom green LED goes out at the end of the 90s period.

The unit then reverts to the heating mode again, with the top two LEDs lit.

Note that if VR4 is not set all the way down to 0V, only the top LED will light. Additionally, the alarm will sound if VR4 is set below 2V, so the piezo transducer should be unplugged during this procedure.

Assuming VR4 is set for 0V at TP4, it's just a matter of adjusting VR5 so

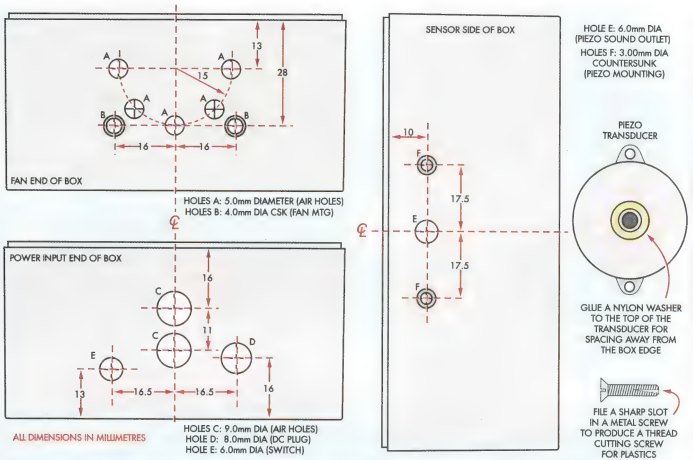


Fig.4: these diagrams can be copied and used directly as drilling templates for the plastic case (the larger holes are best made using a pilot drill and then enlarged to size using a tapered reamer). Also shown are the mounting details for the Nylon washer on the transducer plus the details on modifying a metal screw to so that it cuts a thread in plastic.

that TP5 is at 0.5V when the lowest one or two green LEDs are alight. **Once that's done, be sure to readjust VR4 so that TP4 is at 3V.**

Testing the CO sensor

The best way to confirm that the CO sensor is working correctly is to expose it to car exhaust fumes for at least 2.5 minutes.

This can be done by first capturing some exhaust in a length of plastic tubing (eg, 120 x 16mm-diameter) that's closed at one end. The open end is then held over the CO sensor for 2.5 minutes, during which time the CO bargraph display should rise to full scale.

The display should subsequently switch off again a few minutes after the tube is removed. If it does all this, then the sensor and its circuit are working correctly.

As an aside, it's worth noting that the voltage on TP5 has to rise from the 0.5V fresh-air setting to 2V before the lower LED lights on the CO bargraph. This has been done to prevent the CO bargraph from being oversensitive for readings below 30ppm.

Fitting the board in a case

As stated, the PC board is designed to fit inside a standard IP65 ABS box with a clear lid (Jaycar HB-6246 or equivalent). Before installing it though, you need to drill a few holes to mount the fan and the piezo transducer. You also need to drill clearance holes for the on/off switch (S1) and the DC power socket, a hole directly in front of the piezo transducer and intake and exhaust holes for the fan.

Fig.4 shows the drilling details. It can be copied and cut into sections to make drilling templates.

Once the holes have been drilled, glue a 6mm ID Nylon washer to the top of the piezo transducer (using silicone sealant), then tap the two mounting holes in the transducer to 3mm. If you don't have an M3 tap, then a modified M3 metal screw will suffice to cut the thread – see Fig.4.

All you have to do is file a slot along the thread of the screw, with a deeper cut at the thread end. This slot will assist in the cutting and removal of the plastic to form the thread in each hole.

Similarly, the two bottom mounting holes in the fan housing must be tapped to 4mm. You can use a modified 4mm machine screw (ie, with a slot) to cut the threads if you don't have a proper M4 tap.

The PC board can now be slid into the case and secured using four M3 x 6mm machine screws. That done, secure the fan using two M4 x 12mm countersunk (CSK) head screws, then install the transducer. The latter is fitted with its attached Nylon washer against the side of the case and secured using two M3 x 10mm CSK Nylon screws (don't over-tighten these screws).

Next, attach the transducer's leads to the 2-way female pin header (the polarity is not important) and plug it into the matching male header on the PC board. The fan can then be wired to

the screw terminal block, with the red lead going to the "+" terminal and the black lead to the "-" terminal.

Now check to make sure that the 10µF capacitor at the top end of IC1 doesn't foul the fan. It may be necessary to bend the capacitor back towards IC1 slightly, to ensure adequate clearance.

LED tubing

Each LED can be made to project its light onto a small spot on the front panel label by fitting it with a small light guide made from heatshrink tubing – see photos. You will need 17 x 20mm lengths of 5mm-diameter heatshrink tubing and it's a good idea to use red, yellow and green tubing so that it matches the colours of the LEDs. Alternatively, you can just use black heatshrink.

Once the heatshrink tubes have been cut to length, slide them down over their respective LEDs by about 6mm and shrink them down by gently applying heat from a hot-air gun. They should each form a tight grip around the LEDs and be left with a small circle at the top.

Finally, adjust the LEDs so that the light pipes are all in a straight line. Now, when the lid is in place, each bargraph LED will project a small spot onto its correct position when it is lit. The same goes for the power LED.

Front panel label

The front panel label is made by printing it out on clear overhead projector film. It is then fitted in place inside the clear plastic lid and can be secured using neutral-cure silicone sealant at each corner.

You can download the label in PDF format from the SILICON CHIP website.

Installation

The Air Quality Monitor should be mounted near to the combustion heater and preferably on a wall, so that the display can be easily seen. The box has mounting holes that are accessed with the lid off, so it's easy to fix in position.

Note that it's normal for CO_2 levels to rise while the heater is on. However, the ventilation should be increased if the indicated level rises past the low region on the bargraph.

The carbon monoxide (CO) level in the room should be kept to an absolute minimum and this can be achieved by ensuring that the heater is operating correctly. With wood heaters, this means allowing the temperature to rise sufficiently after the fire has been started, to ensure clean combustion, before reducing the air intake to slow the combustion process.

Finally, never use treated or manufactured timber such as treated pine, medium-density fibreboard (MDF), chip board, hard board or similar in wood fires. These products can produce noxious fumes during combustion. SC

Fig.5: the full-size front panel artwork. Alternatively, a PDF version can be downloaded from the SILICON CHIP website and printed out onto clear film.

Below: the completed prototype with the label in position. The "light pipes" fitted to the LEDs ensure that only the correct "dots" on the bargraphs are lit.

LeCroy waveAce 112

Digital Storage Oscilloscope

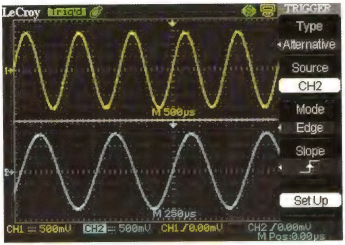
This two-channel, 100MHz Digital Storage Oscilloscope takes up to 500 million samples per second, has comprehensive USB connectivity and a wide range of features in a stylish, compact package

LeCroy are best known for their high-end test equipment. With this series of oscilloscopes they now cater for the entry level Digital Storage Oscilloscope (DSO) market.

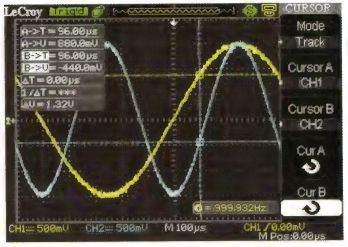
The size and layout of this unit is similar to other entry-level DSOs. One obvious difference is the styling, which makes a nice change from the typical beige and grey boxes. The scope comes with two 1-metre 1x/10x 100MHz probes and accessories, a USB cable, a power cable, a software CD and the Getting Started Manual.

The probe accessories included are a ground spring (which can replace the alligator clip lead for high frequency applications), extra colour coding rings, a compensation adjustment tool and several additional probe tips including some that suit DIP IC pins. These prevent accidental shorting to adjacent pins when taking measurements. There is also a BNC adaptor

Review by Nicholas Vinen



The "Alternative" trigger mode is one of the best features of the WaveAce 112. Here we are viewing sine two waves with unrelated frequencies using different time bases and they are separately synchronised.



This demonstrates the tracking cursors mode. The two cursors have been moved to the same point on both traces and the corresponding times, voltages, and deltas can be read off the measurement panel.

which allows the probes to be plugged directly into BNC sockets.

On the rear panel is a pass/fail output, a serial port and a USB socket for connecting the oscilloscope to a computer or printer. On the front panel, in addition to the screen and controls, is a second USB port for flash memory drives, two BNC connectors for the signal inputs, the external trigger BNC input and a calibration output.

User interface

The display is the now-typical full colour quarter-VGA 5.7" LCD. It is better than average. with excellent contrast and a fast update rate.

Most of the screen area is dedicated to waveform display, which is partially occluded by a menu when accessing extended functions.

Each menu item corresponds to one of five adjacent "soft" buttons. A single button press dismisses this menu at all times.

LeCroy haven't skimped on the controls either – there are separate vertical adjustment knobs for each channel.

Some entry-level DSOs have a common set of knobs with buttons to select which channel is being adjusted. That saves money and reduces clutter but making adjustments becomes significantly more awkward as you can't always remember which channel is currently selected.

Impressively, all of the knobs double as buttons. Pressing a vertical offset knob resets the channel offset to 0V, while pressing the vertical scale button toggles vernier (fine) adjustment for that channel.

Pressing the horizontal scale knob toggles the window (zoom) mode and pressing the horizontal offset knob sets the trigger offset to 0s. Similarly, pressing the trigger level knob sets the trigger level to 0V.

Input circuitry

An important aspect for any DSO is the quality of the analog input circuitry and the analog-to-digital converter (ADC). The WaveAce 112 has an 8-bit, 500MHz ADC (250MHz if both channels are active) with very good noise performance.

Captured waveforms are clean, with a minimal amount of vertical "fuzz". The noise performance is equal to or better than, most entry-level DSOs.

Input sensitivity ranges from 2mV/div to 5V/div with 1x probes. The ability to go down to 2mV/div is very useful for measuring low amplitude signals.

Without any probe attenuation bandwidth is limited to 6MHz, so high frequency measurements are made with 10x attenuation, resulting in a sensitivity of 20mV/div to 50V/div.

Features

There are many buttons on the front panel which provide the extended functions. The table overleaf shows the major functions accessible from each of these buttons.

Some features of this unit stand out. The tracking cursors are not really novel but they are particularly well implemented.

The "print" button allows screen captures to be saved easily at any time, with or without the menu bar. This is important for showing measurements, since the primary measurement mode shows the values within the menu bar itself.

Each channel has a configurable digital filter which can be set to low-pass, high-pass, band-pass or band-reject. In each case the corner frequency is adjustable through a range which depends on the current time base. This is very handy for making certain types of measurements, eg, audio frequency measurements with high frequency noise removed.

Unfortunately, as soon as the run control is stopped the filter is automatically disabled, so it can only be used when viewing "live" data.

The trigger settings are comprehensive and the Alternate (they call it Alternative) trigger mode is outstanding. In this mode, each channel is not only separately triggered but also displayed separately in a split screen.

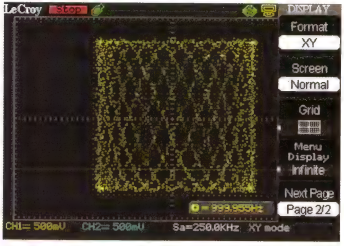
What's more, the time base, trigger type (Edge, Pulse, Video or Slope) and other trigger settings can be adjusted independently. It's like having two complete single channel scopes in one package.

When the WaveAce 112 is plugged into a Windows computer via USB, all functions of the oscilloscope can be controlled and data can be captured directly.

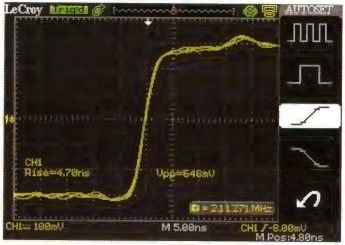
Support for Windows 7 64-bit edition should be available soon from LeCroy.

Automatic adjustments

The "auto" adjustment button works



This pattern arises when sine waves with related frequencies are input on both channels and they are plotted in XY mode. In this mode the display shows dots only but in XT mode, dots or vectors (ie, lines) may be used.

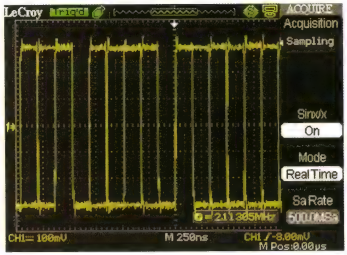


After pressing the "auto" button with an S/PDIF signal connected to channel one we selected the rising edge mode. The waveform rising edge detail is shown along with the rise time and peak-to-peak voltage.

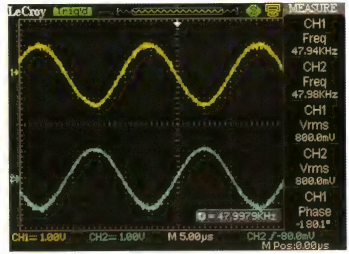
very well. It adjusts the vertical, horizontal and trigger system to suit the detected signals and at the same time automatically displays several pertinent measurements at the bottom of the screen – the peak-to-peak voltage, average voltage, period and frequency.

You can then switch to one of three additional views which show more measurements via an additional button press. If you want to check the rise or fall time of a digital signal, pressing

Button name	Major function description
CH1, CH2	Input coupling (AC/DC), bandwidth limit, invert signal, digital filtering
CURSORS	Manual: provides fixed cursors that can be moved across the display Auto: cursors show the measurements currently being read out Track: cursors can be moved horizontally and voltages read off each waveform
ACQUIRE	Sampling: one reading displayed for each time base increment Peak detect: minimum and maximum values are shown for each time base increment Average: 4/8/16/32/64/128/256 waveforms are time averaged for noise reduction
SAVE/RECALL	Configurations, screen captures and waveform data (as binary or CSV – comma separated values) can be loaded or saved from/to internal or external (USB flash drive) memory.
PRINT	Can be configured to immediately save a screen capture to memory or to print the screen to a USB printer plugged in to the rear panel port
MEASURE	Up to five measurements can be made at one time and are displayed within the menu sidebar. 32 different measurements are available. Alternatively, all measurements from one or more category (voltage, time, period) can be displayed at the bottom of the screen.
DISPLAY	XT mode: normal display mode with time on the X axis and voltage on the Y axis XY mode: channel 1 voltage on the X axis, channel 2 voltage on the Y axis Display persistence: off, 1 second, 2 seconds, 5 seconds or infinite Graticule: full grid, axes only or off Trace intensity and brightness: 0-100%
UTILITY	Allows adjustment of button press beeps, on-screen frequency display, system language, calibration, firmware updates, pass/fail testing, waveform recording, screen blanking, serial port baud rate, etc.
MATH	Operators: add, subtract, multiply, divide, FFT (Fast Fourier Transform) FFT options: window type, zoom, scale, full/split screen The result is displayed as a third, green trace
REF	Allows one or two reference waveforms to be captured from an input and displayed on screen (in red and mauve) for comparison to measured waveforms.
TRIG	Mode: Edge, Pulse, Video, Slope, Alternative Common settings: Source (CH1/CH2), Mode (Auto, Normal or Single), coupling (AC/DC), holdoff time Edge settings: Slope (positive, negative, both) Pulse settings: When (positive/negative, less than/greater than/equal to), width Video settings: Polarity, Sync (All lines, line num, odd field, even field), NTSC/PAL Slope settings: When (positive/negative, less than/greater than/equal to), time, polarity Alternative settings: see text



Fast rise and fall times are not a problem for this oscilloscope. Here we have fed in a 3.072MHz S/PDIF stream and the edges are not rounded. The overlaid traces are dued to the biphase encoding.



This image shows how up to five individual measurements are displayed in the menu bar at the right edge of the display. The frequency can also optionally be displayed below the traces.

the corresponding button zooms in to the leading or trailing edge of the waveform and the rise/fall time and peak-to-peak voltage are shown.

The third additional button zooms in to examine one wave cycle with readings for the minimum, average and maximum voltage as well as the pulse width.

Conclusion

These are all great features and overall, the WaveAce 112 gives an impression of a very well though-out user interface.

This makes the few awkward aspects all the more baffling. The unit can clearly display readings at the bottom of the screen (see top right of previous page). So why can individual user-selected measurements only be shown in the menu (see top right above).

This issue could be fixed with a future firmware patch. So could the unnecessarily large number of button presses required each time a screen capture is saved (with the addition of an automatic sequential file naming feature).

And while it is a minor quibble, it would be nice to have a split-screen zoom display in the window mode, which some competing models provide. If LeCroy could update the firmware to sort out those three issues, the WaveAce 112 would be just about the perfect entry-level DSO. The combination of features and performance means it is good value, even though it costs a little more than some competing models.

For those with smaller budgets, the 60MHz and 40MHz models provide the same features for much less money.

Pricing & availability

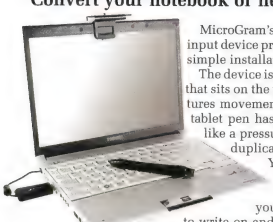
Currently, the WaveAce 112 (100MHz) is available from Vicom (www.vicom.com.au) for $1850+GST, with a 3-year warranty. The WaveAce 102 (60MHz) is $1470+GST and the WaveAce 101 (40MHz) is $1040+GST.

Vicom hope soon to offer online sales for these units at lower prices (to be determined).

For further details, contact Vicom (mzahra@vicom.com.au) or call (03) 9563 7844. Quote SCM1006 for a SILICON CHIP reader discount. SC

PRODUCT SHOWCASE

Convert your notebook or netbook into touch screen



MicroGram's USB Tablet Attachment is a pen input device providing full tablet functionality with simple installation.

The device is made up of a webcam-sized receiver that sits on the top of your laptop's screen, and captures movement through a special tablet pen. The tablet pen has standard stylus type functionality like a pressure sensitive tip and side buttons to duplicate the mouse buttons.

You can also replace the tip on the stylus with an ink-filled tip, then simply move the transceiver from your notebook screen to what you plan to write on and you can now produce hard copies of your drawings and written text while simultaneously creating a digital copy.

It's only compatible with Microsoft Windows XP and Vista but it acts just like a real tablet, making it possible to draw, write, sketch and illustrate. You don't even have to touch the pen to the screen – it works in the air, just like the Nintendo Wii.

The USB Table Attachment works with multiple software applications such as Photoshop, Illustrator, PDF, Microsoft Outlook, Sticky Note, and more.

Hardware requirements are a screen size of 15.4" or less, a Pentium-compatible CPU over 1GHz and more than 512MB of RAM. A CD-ROM drive is also required.

RRP is $319.00 inc GST.

Contact:
Microgram Computers
PO Box 8202, Tumbi Umbi, NSW 2261
Tel: (02) 1800 625 777 **Fax:** (02) 4389 0234
Website: www.mgram.com.au

NIC Portable Video Scope from MachineryHouse

The Toolmaster NIC portable video scope from Hare&Forbes/Machineryhouse is a revolutionary tool that will make inspection easier with greater visibility for examining hard-to-reach places.

A 12mm diameter camera-tipped probe with built-in adjustable LED lighting, mounted on a 1m-long flex-and-stay shaft allows visual inspection of otherwise inaccessible areas – for example, inside machinery or equipment and other concealed spaces.

The inbuilt colour monitor features 60mm high resolution LCD screen with intensity control for the LED lights, giving superb clarity even in dark places.

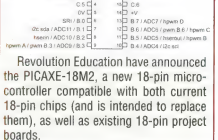
Powered by a 9V battery, it is designed especially for the automotive, aerospace, electronics and engineering industries and performs extremely well. Compact in size and boasting extremely bright illumination, the NIC Portable Video Scope is sure to impress.

The kit, which retails for $239 (+GST), includes a protective carry case, a mirror tool plus magnetic and hook tips.

Optional 3 & 5 metre cable lengths are available.

Contact:
Hare&Forbes Machineryhouse
Unit 1/2 Windsor Rd, Northmead NSW 2152
Tel: (02) 9890 9111
Website: www.machineryhouse.com.au

New fire-breathing PICAXE chip: the 18M2!



Revolution Education have announced the PICAXE-18M2, a new 18-pin microcontroller compatible with both current 18-pin chips (and is intended to replace them), as well as existing 18-pin project boards.

The new PICAXE-18M2 adds many new and improved features, at much the same cost as the earlier 18s it replaces:

- Almost every pin is individually configurable.
- Many extra ADC channels are now also available on other pins.
- The reset and serial input pins can now be used as 2 extra input pins
- The 18M2 can now run four separate tasks in parallel.
- The 18M2 device replaces all of the older 18/18A/18M/18X parts and so gives 18X equivalent memory capacity (2048 bytes, up to 1800 lines of program)
- Fully backwards compatible with all existing 18-pin PICAXE project boards and programs written for any older 18 pin PICAXE part.
- New lower 1.8V operation now makes the 18M2 ideal for use with 3V battery packs
- Twice as many (now 28) general purpose byte variables, with a total of 256 bytes of RAM.
- New 'time' variable counts elapsed seconds.
- Separate 256 bytes of non-volatile data EEPROM memory.
- Faster internal resonator (up to 32MHz) means up to 8x faster program processing.

Revolution Education products, including PICAXE chips, are distributed in Australia by Microzed.

Contact:
Microzed
PO Box 5103, Chittaway Bay NSW 2261
Tel: 1300 735 420 **Fax:** 1300 735 421
Website: www.microzed.com.au

Australia's lowest price for a colour DSO?

Trio-Smartcal have introduced what they believe is Australia's lowest price for a quality colour Digital Storage Oscilloscope – and there's even a special discount for SILICON CHIP readers.

The two-channel UQ3022C sports a 25MHz bandwidth, a 500MSa/s sampling and a colour TFT display. Its advanced functions include FFT, pass fail testing, advanced trigger modes, 6-digit frequency counter, digital filter and of course full USB support for memory sticks and PC communications.

It is supplied with two 1:1/10:1 probes, USB and power cables, EasyScope3.0 software, certification and a user manual. List price is $449.00 (+GST) but for June if you quote "SILICON CHIP" when ordering, the UQ3022C is yours for $425.00 (+GST).

Contact:
Trio-Smartcal Pty Ltd
3 Byfield Street, North Ryde NSW 2113
Tel: (02) 9850 0200 **Fax**: 1300 853 409
Website: www.trio.com.au

ioDrive Duo: the world's fastest and most innovative SSD

The new ioDrive Duo is the market's fastest and most innovative server-based solid-state storage solution. With the ioDrive Duo, it is now possible for application, database and system administrators to get previously unheard-of levels of performance, protection and capacity utilization from a single server. Performance for multiple ioDrive Duos scales linearly, allowing any enterprise to scale performance to six gigabytes per-second of read bandwidth and over 500,000 read IOPS by using just four ioDrive Duos.

Based on PCI Express x8 or PCI Express 2.0 x4 standards, which can sustain up to 20 gigabits per-second of raw throughput, the ioDrive Duo can easily sustain 1.5 Gbytes/sec of read bandwidth and nearly 200,000 read IOPS. Its sustained read bandwidth is 1500 MB/sec; sustained write bandwidth: 1400 MB/sec (both with 32k packet size); read IOPS: 186,000 and write IOPS: 167,000 (both 4k packet size). Latency is less than 50µs.

The ioDrive Duo comes in 160, 320, 640 and 1280GB capacities.

Contact:
Pixel IT Pty Ltd
22/1 East Ridge Dve, Chirnside Park 3116
Tel: 1800 674 935
Website: www.pixel.com.au

International "USB" plugpack supply

With so many devices designed to be powered from USB ports these days, you often run out of USB ports (or the PC is turned off when you need it!).

Altronics have introduced this nifty plugpack supply which not only provides 5V@1A from its standard USB-A output socket, it also comes with a variety of clip-on international mains plugs so you can take it with you overseas (input voltage is 100-240V AC).

So now you can power your iPods, MP3/MP4 players, PDAs, mobile phones etc, when you're away from a computer, as long as there is a mains power supply.

Cat M-8890A is normally available from all Altronics stores, resellers and via their web store for $19.95 but is currently on special at just $17.00 (special until the end of this month).

Contact:
Altronic Distributors Pty Ltd
PO Box 8350, Perth Busn Centre, WA 6849
Tel: 1300 780 999 **Fax**: 1300 790 999
Website: www.altronics.com.au

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SERVICEMAN'S LOG

Carbon based failures are all too common

Not all faults in equipment are hardware or software based but are instead due to carbon-based failures or CBFs, as in carbon-based life forms. Unfortunately, CBFs can really waste your time.

Items Covered This Month

- Carbon-based failures
- The mosquito that died happy
- Is it electrical or fuel?
- Faulty air-conditioning controller

My first story this month comes from T. M. of St Agnes, SA and concerns faults in biomedical equipment. Here's the story in his own words . . .

For the last 19 years, I have worked as a Biomedical Engineering Technician for one of the largest pathology providers in Australia. For most of that time, I have worked in a team that looks after all our regional labs. These can range from quite large labs with several hundred staff to small labs at country hospitals with only four or so staff members.

As with most modern equipment, the majority of problems are not strictly electronics related. Most of the gear in this industry is built in the USA, Europe or Japan by large corporations with huge design budgets. Failures in the medical industry can sometimes literally be a life or death situation and so the design and construction of such equipment is to a very high standard.

Certainly, the companies involved are not interested is sacrificing component quality just to save a few dollars.

As a result, most of our equipment is quite reliable. Even so, I have a team of seven guys who work hard at fixing the analysers that the supplier's sales reps tell us (at the time of purchase) should never break down.

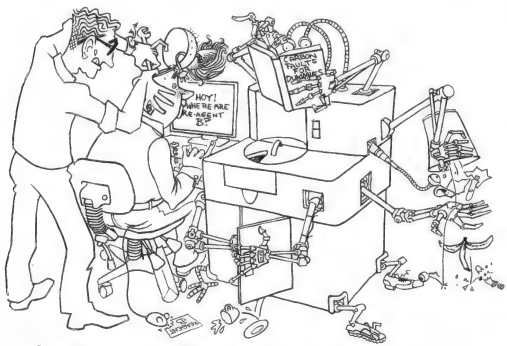
One morning, I received a call from a Lab Manager complaining that his main chemistry analyser was reporting an error along the lines of "Can't find reagent B". Chemistry analysers usually have one or more thin probes attached to robotic arms that pick up samples or reagents and place them into a small cuvette (or tube), where a chemical reaction takes place. Light is then shone through the cuvette and the absorbance of the light at different wavelengths is measured.

By measuring the absolute figure, rate of change or a peak value, the analyser can determine the amount of a certain chemical that was originally present in the sample. The results mean something to our medical fraternity but usually don't mean much to the engineering staff, especially as the chemical name is usually shortened to a code such as "T4" or "Dig" etc.

The volumes of both the sample and the reagent are kept very small for each test. Apart from anything else, keeping reagent volumes to a minimum is a cost-saving exercise as the number of tests each machine does in a week can run into the thousands.

Normally, a liquid-level sense circuit is incorporated on the probe, allowing the probe to draw a reagent or sample from the top of the fluid. This is done to minimise "wetting" of the outside of the probe, thus reducing carry over and contamination. The liquid level sensing is usually achieved by monitoring the capacitance of the probe and looking for a step change as it touches the surface.

Anyway, back to the "Can't find reagent B" problem. Initially, I spent a few hours on the phone with the Lab Manager, going through various things to check . . . "Have you changed the reagent pack? Is it empty? Has the sig-



REPAIRING A CHEMISTRY ANALYSER'S CARBON-BASED FAILURE

nal wire broken from the probe? Take the probe out and ensure that there is no corrosion at the mounting sleeve (this isn't unheard of and will insulate the signal back from the probe). Is the reagent bottle properly earthed? Have there been any spills, resulting in dried conductive salt deposits interfering with the level sense signal?"

After exhausting all these and other ideas without result, there was nothing for it but to make the 3-hour trip to the lab with my tools and spares to check out the problem with the robot arm. When I arrived about mid-afternoon, I immediately looked into the reagent B bottle and saw that it was nearly empty. As a result, I asked the lab manager to get me a new bottle of reagent, after which the analyser worked perfectly, much to the mixed emotions of the lab manager.

In fact, he was very red-faced. He had, after all, spent half a day trying to fix an analyser that was reporting that it couldn't find a reagent that wasn't there. Much to his embarrassment, the fault had been fixed less than a minute after my arrival and that was without opening the tool box!

His excuse was that he thought one of his night-staff had changed the reagent while trying to fix the "fault" and he hadn't rechecked it – this despite the fact that I had asked him to do this at the start of the phone call.

This type of fault is what we tactfully call a CBF or "Carbon Based Failure" (as in, carbon-based life forms). The operators don't like getting service reports with "Operator Error" written on them!

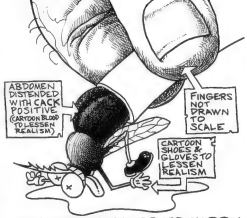
The mosquito that died happy

Another "Carbon Based Failure" occurred one Sunday when I got a call from one of our large metropolitan labs, the operator complaining that one of their major chemistry analysers had stopped working. According to him, there were no lights, buzzes, whirrs or any other signs of life. It was just "dead"!

"So much for my nice relaxing Sunday afternoon", I thought as I headed off to the lab with my tools to investigate. However, it didn't take long to get an inkling of what the problem might be because as I was walking into the lab, I noticed that most of the lights were off. What's more, as soon as I got there, someone said "Thank heavens you're here because you can check that box under the bench as well. It's been beeping and driving us all crazy but at least it's stopped for now".

The "box" he was referring to was the 6kVA UPS (uninterruptible power supply). The beeping noise it had been making was simply a warning that it was running on batteries, as the power had failed. The beeps had then stopped when the batteries went flat, thus resulting in the power to the analyser dropping out.

It always amazes me how the addition of a UPS is the apparent answer to all problems. We normally install them to keep equipment operational during the time it takes for a back-up



THE MOZZY THAT DIED HAPPY...

generator to kick in if the mains power fails. Even though the generators start up in a few seconds, computer systems only take a split second to shut down and the analysers "go down" with them, thereby losing any work that may be in progress.

In many of our hospitals, the load on the generators is normally heading towards full capacity. In this particular case, a decision was made not to put the second major analyser on emergency power for this very reason. Instead, the UPS was rated to allow enough time for the "main" analyser to finish the work that had already been loaded onto it, after which the operator could then do a controlled shut-down.

My next call was to service a blood gas analyser that wouldn't give any results. "The electronics must have failed as I have put in a new sensor. You need to come quickly!", was the plea from the operator.

In operation, blood gas analysers take a whole blood sample and meas-

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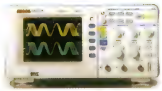

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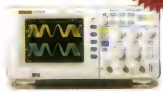

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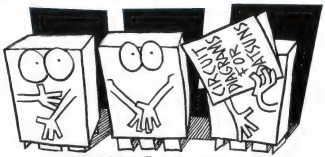


ure the pH and the amount of oxygen and carbon dioxide being carried by the blood. Usually, the labs want them fixed as soon as possible, as the results are clinically important to the medical staff. What's more, the samples normally can't be sent between sites as they have a very short shelf life. Apparently, atmospheric gases can contaminate the sample and make the readings invalid.

When I arrived, I quickly determined that the blood wasn't being presented to the electrodes. The reason for this was a blockage in one of the fine tubes between where the syringe is presented and the electrode housing. This is not that uncommon as the syringes that are used for collecting the sample have a chemical in them that is meant to mix with the blood to stop it from clotting.

Basically, the nurse is required to roll the syringe a few times after taking a sample to thoroughly mix the blood. Failing to do this will cause some of the blood to clot and this can subsequently be injected into the analyser, causing blockages.

I muttered something under my breath along the lines of "when will the @#$%^& staff learn to mix their samples"? and proceeded to pull the analyser apart to clean out the tubing. But it wasn't a clot – instead, I was surprised to find a mosquito corpse stuck in the main sample path! The mosquito must have thought it had found an absolute feast, only to be sucked up into the machine to a messy end.

My next story come from P. W. of Hope Valley in SA. Here it is . . .

Is it electrical or fuel?

My son has a 1991 Nissan Nomad van (8-seater) which developed an annoying intermittent engine problem. The engine (petrol/carburettor) would start and run for some time but then would stop without any warning and sometimes in the most inconvenient and dangerous road locations. And when it stopped, it would initially refuse to restart.

After a few minutes, it would then generally start again and operate normally until the next episode.

On one occasion, on the way to the repair garage, the vehicle broke down at a T-intersection. Unfortunately, the direction of travel was uphill and a 50-seat passenger bus pulled up behind, followed by numerous other cars. There was only one direction to go and that was to push the van uphill and to the side of the road, to allow the bus and other vehicles to drive around us. Even the bus driver helped to push.

The intermittent problem was very frustrating as it was possible to drive for some days without incident. Even an extended test drive by the repair shop mechanic failed to re-create the problem.

Under these conditions, diagnosis is very difficult and so I adopted the elimination method of fault finding. To begin, I talked to the experts, with the consensus being that it was either the ignition system electrics or the fuel system. It also seemed that it might be temperature related.

The ignition system was the most likely suspect, because the engine always stopped suddenly without any warning. If it were a fuel problem, some surging of the engine would normally be expected prior to stopping.

Unfortunately, this vehicle has a twin spark system (two plugs per cylinder) and an electronic distributor. The repair mechanic suggested that a replacement distributor may be difficult to source and would be expensive. Considering the age of the van, a replacement might be uneconomical, leaving us with little choice but to scrap the vehicle.

With that in mind, I decided to come up with a scheme to cheaply test the ignition system. I had an old ignition timing light in my workshop and after a good rummage around, I located it and connected it to the van's battery and number one spark lead. My theory was that if the problem was lack of spark, I just needed to wait until the engine stopped and then crank the engine with the timing light hooked up. If the timing lamp flashed, then the ignition system was working and could be eliminated as the cause of the problem.

Conversely, if there were no flashes, the ignition system would need to be checked out.

It was not long before the engine stopped and I tried the timing light. Bright flashes were immediately visible when the engine was cranked, thus eliminating the ignition system as the culprit.

Electric fuel pump

The next thing to look at was the fuel system. The van has an electric fuel pump in the fuel tank, so the main possibilities included a faulty fuel pump, a faulty fuel pump relay, a faulty electrical connection or fuse, a blocked fuel filter or a faulty carburettor or carburettor float valve. An electrical circuit diagram of the fuel system layout would have been useful but checking the Internet and two large local libraries drew a blank.

The expert advice was that I should wait until the van stopped and then check to see whether there was fuel visible in the sight glass on the side of the carburettor. If fuel were not visible, then it would be a fuel delivery problem. Conversely, if the fuel was visible, then the problem would be a sticky float valve or blockage in the carburettor.

Any person who has owned or worked on a van with the engine under and between the front seats knows that it is almost impossible to find the carburettor, let alone see an obscure sight glass on the side. I looked and looked and even removed some side

panel covers and crawled underneath but to no avail. The sight glass remained "unsighted".

At this time, I consulted the repair mechanic and we decided that the first item to replace would be the fuel filter, followed by the fuel pump. The process would be to change the filter first and then test the pump delivery pressure. He also had some good news on the fuel pump if it needed replacement – it was currently being offered by his supplier at a special stock run-out price.

Anyway, the filter was replaced and the pump delivery pressure checked. This was found to be erratic, pointing to a problem with the pump itself. It was replaced and thinking that we had finally cracked the problem, we drove off towards home.

You've guessed it – just 2km down the road, the engine stopped again.

We eventually got home and parked the van in the driveway. It sat there until the following Saturday afternoon, at which point I gathered my tools together and resolved to solve the problem once and for all.

The first port of call was the connector closest to the fuel tank. This connector routes the +12V and ground supply leads to the fuel pump and also handles the wiring from the fuel-tank level sender.

After switching on the ignition, I identified each connection and checked the +12V supply to the pump circuit. This voltage initially wavered somewhat but then remained steady. This seemed odd so I plugged the connector in and listened for the sound of the pump. It ran OK so I switched the ignition off to think about where to go next. If the voltage was varying, then there was a poor connection somewhere, most likely in the fuel pump relay.

Tracking down the fuel pump relay

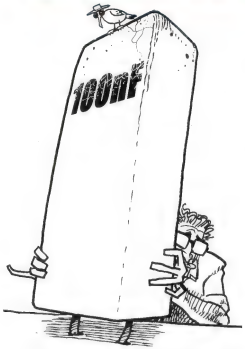
So where was the fuel pump relay located? Looking under the dash, I found a cluster of four relays plus a further two relays near the steering column. None were labelled to indicate their function but because the fuel pump only runs when the ignition is on, I decided to listen to the relays when the key was turned. That way, I could narrow down the likely suspects.

I removed the relays that clicked and then checked each one in turn using a multimeter and a 12V supply from the van battery. They all tested OK so I replaced them and tried the ignition again. This time, there was no noise from the fuel pump at all, so it wasn't running.

I tried turning the ignition off and on a number of times and eventually got the fuel pump working – well, for most of the time. I was on the right track but where was the fuel pump relay? I again removed the previous clicking relays and then listened carefully as I operated the ignition key. Eventually, I was able to detect a faint clicking sound somewhere near the glove compartment.

In the end, I concluded that the sound was coming from behind the glove box. The glove box was quickly removed and then a steel panel behind it was moved to expose a further three relays. I then identified the fuel pump relay by matching one of its colour-coded leads to the +12V lead going to the fuel pump connector.

At this time I thought that a screwdriver "tap test" might be useful to confirm the problem, my thinking being that the relay contacts were probably at the end



~SO I REPLACED IT WITH A MONOLITHIC TYPE

of their useful life. And so, with the ignition on, I carefully tapped the relay while listening for the sound of the fuel pump. The fuel pump responded immediately when the relay was tapped, the pump noise varying in pitch and often stopping and starting. The culprit had finally been nailed.

Having identified the cause of the problem, it was time to fix it. The relay was unplugged from the harness and the circuit board and plug contacts removed from the plastic case after some careful prising with a flat-blade screwdriver. A quick examination revealed that the circuit board held a small 9V relay plus two transistors and a handful of resistors.

Everything looked OK on the component side of the board, so I turned it over to check the track side. And that's when I spied a dark circle around one of the solder pads on one of the relay pins. A good solder joint should be shiny and bright but this joint had a dark circle between the centre of the pin and the outside of the pad.

In short, it was a typical dry joint problem and it affected the pin that supplies +12V to the fuel pump.

Clearly, the amount of solder applied to this pin had been marginal. It had lasted 19 years but after repeated thermal cycling and vibration, had now become intermittent.

It took no more than a minute to resolder this connection and all the other connections on the board for good measure. The relay was then reinstalled and a long test drive confirmed that the problem had finally been solved. What a relief!

However, this incident shows just how difficult and costly an intermittent fault can be to diagnose. There were times when we thought that the only reasonable outcome would be to scrap the vehicle and I wonder whether other people have faced similar problems with this particular model.

On the other hand, it's quite possible that a visit to the local Nissan dealer would have quickly solved the problem. Perhaps, in their repair knowledge base, they have a solution for this type of intermittent fault that reads "Replace the fuel pump relay behind the glove compartment (left-hand relay)".

Air-conditioning controller

The final story this month comes from R. G. of Cooloola Cove, Qld and concerns a faulty air-conditioner controller . . .

Recently, my wife observed that the temperature controller on our air-conditioner was showing a blank screen. Because it was the middle of summer, I decided I'd better take a look at it straight away.

I initially thought that the batteries were probably flat and that I would have it fixed in no time. However, when I removed the cover, I found a lot of corrosion on one of the terminals, so I cleaned it up and installed some fresh batteries. Much to my surprise, this didn't fix the problem so I unclipped the unit off the wall and took it down to the workshop.

The unit is manufactured by Arlec and controls a through-the-wall air conditioner. It has some nice features that I would lose with an ordinary thermostat. The problem is that, in view of their age, these units are probably no longer available, so I was going to have to repair it.

Having placed it on the workbench, I removed the circuit board and checked for more corrosion. There was some dust and dirt but all seemed to be OK. I gave it a good clean just to make sure and replaced the wire attached to the corroded terminal. I then put it back together, inserted the batteries and the screen came on at full brightness.

Thinking that that would be the end of the matter, I clipped it back on the wall but the screen went blank again less than an hour later.

Back in the workshop, I pulled it apart to check out the elastomeric strip that connects the LCD screen to the circuit board. The contacts looked OK but I gave them a good clean anyway and reassembled the unit. I then installed the batteries and once again the screen came on at full brilliance, so I clipped it back on to the wall.

This time, it lasted no more than 30 minutes before going blank again. It was time for a bit of a think.

One thing I had noticed was that the unit had become quite warm while I was working on it, due to a 50W QH 50mm reflector lamp that I was using for illumination. Thinking that the fault might be heat sensitive, I used the lamp to warm the controller while I watched the screen. Sure enough, it quickly came good but when I let it cool down, the screen went blank again.

Next, I tried heating up individual components one at a time by touching their leads with a soldering iron for a few seconds. This made no difference and I was beginning to suspect the main IC which is under a blob of black epoxy. However, I wasn't going to give up easily, so I tested all the transistors and replaced the two electrolytic capacitors. I then reassembled the unit but only had a very faint screen.

I then tried the heat test on the ceramic capacitors and when I tested C4, the screen went blank. This had me puzzled because heating things up used to make the screen come on. Now it was making things worse.

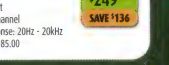
To make sure that C4 was the culprit I sprayed it with freezer spray and the screen reappeared but only faintly. I then removed C4 only to find that it did not have any markings. I tested it in my capacitance meter and this gave a value of 100nF which I considered reasonable considering its physical size.

I didn't have a ceramic type of that value so I replaced it with a monolithic type. And that finally fixed the problem because the display has been at full brilliance ever since. SC

JUNE CLEARANCE SALE!

In-Dash Multimedia Player with 3" TFT Screen & Detachable Face

This excellent unit will play DVDs, VCDs, MP3s, CDs, and AM/FM radio. The built-in 3" TFT screen doubles as a control panel when listening to MP3s etc. It also has an auxiliary audio input for external MP3 or tape player etc. The player fits a standard DIN slot and has a detachable face and can be operated by the included remote. Mounting hardware included.



- Resolution 500TV lines
- 2 x video inputs
- 1 x camera input
- 45W RMS per channel
- Frequency response: 20Hz - 20kHz

QM-3787 WAS $385.00

$249.00 SAVE $136

7" USB Plug & Play LCD Monitor

If you're in dire need of more screen real estate and don't want the hassle of a big bulky secondary monitor that needs its own power supply and display cable, this USB monitor is perfect. It's great if you're busy playing a game and still want access to your IM program like MSN or Skype. The screen has a nifty little rotatable screen and the display can be adjusted accordingly for portrait or landscape view.

NEW

- Compatible with Windows 2000/XP/Vista/7
- Dimensions:188(L) x 114(W) 35(H)mm

QM-3748

$269.00

Mixing Console with Digital Effects

The ideal small mixer for home recording or small PA systems etc. This is a well-featured little unit with high and low mic inputs, separate EQ, gain and pan controls, aux send and return for effects, recording outputs and phantom power.

- Four mono channels with high & low impedance inputs
- 2 stereo channels
- Dimensions: 270(W) x 270(H) x 50(D)mm

AM-4204

$299.00

HDMI Cable Tester

Designed to check and troubleshoot the pin connections of Type A HDMI cables quickly and easily. It's ideal for testing the continuity of each signal pin of an HDMI cable prior to installation. Requires 9V battery.

$89.00 SAVE $60

- Carry case included
- Dimensions: 215(L) x 38(W) x 36(H)mm

AA-0406 WAS $149.00

Halogen Replacement Bulbs Nice and Bright

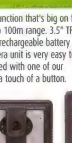
NEW

A range of drop-in replacement halogen globes that will fit standard bayonet or Edison screw fittings, use only ⅓ the energy and last for over 1000 hours. Being halogen they give the same warm quality of light that everyone is used to. Sizes for any room or use:

42W Edison Screw	Pk 2	Cat SL-2795
42W Bayonet	Pk 2	Cat SL-2796
100W Edison Screw	Pk 2	Cat SL-2797
100W Bayonet	Pk 2	Cat SL-2798

$5.95

NEW SHEPPARTON STORE

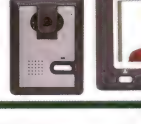


4, 575-585 Southside Wyndham St. Shepparton VIC 3630 Ph: (03) 5822 4037

Wireless Colour Video Doorphone

A compact wireless video doorphone with handsfree call and talk function that's big on features. Digital encryption, code-hopping 2.4GHz wireless transmission up to 100m range. 3.5" TFT LCD and can store up to 200 images internally. It also has a built-in rechargeable battery so you can take the monitor anywhere around the house. The camera unit is very easy to install and equipped with a wide angle lens and IR illuminator. Paired with one of our electric door strikes (see below) and your door can be unlocked at a touch of a button.

NEW



$299.00

- 2.4GHz wireless transmission
- Clear night vision
- Dimensions: 290(W) x 210(H) x 50(D)mm

QC-3253

Also available: Electric Door Strikes:

STANDARD	- Fail Secure	LA-5078	$49.95
	- Fail Safe	LA-5081	$39.95
NARROW	- Fail Secure	LA-5077	$29.95
	- Fail Safe	LA-5079	$29.95

200W PA Combo Amp/Speaker

A PA system in a box. 3 channels with balanced and unbalanced inputs, and line level RCA inputs for an auxiliary source. The ideal small PA for schools, sports organisations, churches, weddings and conferences.

- 12" speaker
- 2 channel equaliser
- 200WRMS power output
- Dimensions: 600(H) x 410(W) x 325(D)mm

CS-2517 WAS $469.00

$329.00 SAVE $140

Also available Portable Combo 30W PA Amp with USB CS-2519 Was $299.00 Now $229.00 Save $70

5.8GHz Matrix Audio Video Sender with Remote

Allows you to watch or record one source in one room while you transmit a different source to another room. You can watch, record or transmit a composite video source or RF from your TV in any combination. It transmits on the 5.8GHz band for minimal interference. Includes remote control for transmitter and receiver.

- Transmission range- 100m
- Power supply: 9VDC, 400mA

AR-1882 WAS $229.00

$129.00 SAVE $100

Spare receivers to suit available separately

AR-1883 Was $99.00 Now $79.00 Save $20.00

4 Channel H264 DVR / Camera Kit

Multiplexing DVR system with H.264 compression technology - complete with four IR outdoor CCD cameras, four 20 metre pre-wired camera cables and power supply. The DVR delivers quality image reproduction at a touch of a button, plus built-in Ethernet capability that enables the unit to be accessed (with password protection) via the Internet using a standard web browser. The recorder features advanced motion trigger recording, video loss detection, remote network record and USB back-up support. Just add a TV or monitor for a complete surveillance system.

250GB HDD

$799.00 SAVE $100

Special Intro Price

QV-8100 WAS $899.00

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1A / 142 Brisbane Rd Labrador QLD 4215 Ph: (07) 5537 4295

www.jaycar.com.au

To order call 1800 022 888

Jaycar Electronics — Better, More Technical

Prices valid until 23/06/2010. Limited stock on sale items. No rainchecks. All Savings are based on Original RRP

SolarWorx Grid-Tie Inverters

Claim Solar Credit rebates from the Australian government with a solar panel array 1KW or over.
But also get paid for surplus solar energy by connecting to your local electricity grid through a grid-tie inverter. These SolarWorx grid-tie inverters feature Maximum Power Point Tracking (MPPT) for direct solar to grid connection. Alternatively, they can be connected via your battery bank to convert battery stored power and feed that back into the grid. This bonus feature gives you the flexibility to add multiple renewable power sources to your solar battery bank (e.g. wind and hydro), or even add an advanced power management system such as our SuperCombi or CombiPlus for full blackout and power backup protection.

Too many features to mention, and backed by an Australian-serviced 2 year manufacturer's warranty, with extended warranty options also available. See our website, or go to "www.nichelectric.com.au" for more information. Take advantage of the generous "feed-in tariffs" from energy providers for the electricity that your solar panels generate. Contact your local electricity provider for details - tariffs vary from state to state.

Two models available:

Grid Tie Inverter 12VDC 2000W	MI-5192	$2799.00
Grid Tie Inverter 24VDC 2000W	MI-5194	$2799.00

50W Telescopic Vertical Axis Wind Generator

A vertical axis generator that can be mounted on a mobile home, caravan or small building. The telescopic design means you can fold the generator to half its height when not in use and an LED display give you a readout of output voltage so you know when it's working effectively. Cables, mounting bars and a strong magnetic base are included.

- Voltage output: 12-14VDC
- Current output: 4A max
- Weight: 4.5kgs
- Compact design with no spinning blades
- Not sensitive to wind direction
- Effective with wind speed of 8 - 10m/s
- Dimensions: 455/655(H) x 280(W) x 150(D)mm

MG-4570 **$399.00**

185 Lumen CREE® LED Head Torch

A powerful head torch for work in dark places or when you're out in the wilderness. It outputs 185 Lumens of white light and features an adjustable head strap

- 8hr run time
- Requires 2 x AA batteries

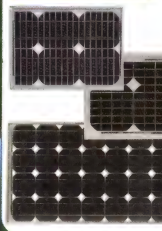
SF-3283 **$39.95**

Powertech Monocrystalline Solar Panels

MASSIVE SAVINGS ON POWERTECH SOLAR PANELS!
As strong and tough as the better known brands, but at a more attractive price.

- Sizes range from 5 watts to a massive 175 watts
- QC tested - all come with test certificate
- 20 year limited warranty

NEW 40W PANEL IN STOCK NOW (Cat. ZM-9093)



	CAT			CAT	
12V 5 Watt	ZM-9091	$39.95	12V 65 Watt	ZM-9096	$399.00
12V 10 Watt	ZM-9093	$89.95	12V 80 Watt	ZM-9097	$449.00
12V 20 Watt	ZM-9094	$129.00	12V 120 Watt	ZM-9098	$695.00
12V 40 Watt	ZM-9095	$249.00	24V 175 Watt	ZM-9099	$949.00

Solar that Really Works

A highly informative and practical guide showing the do's and don'ts of DIY solar installation. From caravans to fishing lodges, it features detailed descriptions of working solar systems with illustrations. Written by acclaimed Australian author Collyn Rivers.

- Softcover, 82 pages, 290 x 210mm

BE-1535 **$42.50**

Also available in this series:
Solar Success Cat. BE-1537 $47.50
Motorhome Electrics Cat. BE-1536 $42.50

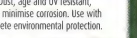
Self Contained Solar Lighting System

Everything you need to get a basic solar setup off the ground. All the components needed are included in the kit: 5 watt solar panel encapsulated in tempered glass, 7Ah SLA battery and 2 x 12V 5W energy saving fluorescent lights. The battery is housed in a sturdy metal enclosure with DC sockets for all the connections, so it's straightforward to set up and use.

MP-4551 WAS $189.00 **$114.00** **SAVE $75**

UV Stabilised Solar Power Cable

Very tough cable, specifically for the rigours of outdoor use in solar panel installations. Dust, age and UV resistant, tinned copper conductors to minimise corrosion. Use with our PV connectors for complete environmental protection. Contact us for a data sheet.



- IP65 rated

2.5mm sq.	**42A**	Cat. WH-3120	$4.50 / metre
4mm sq.	**58A**	Cat. WH-3121	$5.00 / metre
6mm sq.	**76A**	Cat. WH-3122	$8.60 / metre

IP67 LTW PV Crimp Connectors

High quality LTW brand IP67 rated connectors for PV (solar) installations. Features high quality nickel plated crimping ferrule. Suitable for 12AWG (4mm2) solar cable, (see WH-3121 above). Requires 4mm-hex crimping tool.

- Low conduction loss
- Exceeds TÜV and UL standards
- TÜV approved

Crimp Socket 4mm Cat. PS-5200 $12.95
Crimp Plug 4mm Cat. PP-5202 $12.95

Ergonomic Supercrimp Tool & PV Connector Die

This super heavy-duty ergonomic crimper requires 40-50% less handle-force. With a pressure adjustment dial for variable actuation force, it uses interchangeable dies (available separately) for a wide range of crimping applications.

TH-1950 **$49.95**

To suit: **PV Connector Die** Cat. TH-1959 $29.95
See website or catalogue for full range of dies to suit.

Deep Cycle Gel Battery - 12V 100Ah

Deep-cycle gel performance for solar installations and other alternative energy systems.

- Capacity: 100Ah
- Initial charge current: 30A
- Cycle voltage: 14.4 - 15V
- Standby voltage: 13.5 - 13.8V
- Weight: 31.5kg
- Dimensions: 330(L) x 173(W) x 223(H)

SB-1695 **$499.00**

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To order call 1800 022 888

JUNE CLEARANCE SALE

Low Voltage Battery Isolator

With microprocessor control, this indispensable device monitors the output voltage of any 12V lead-acid battery. If the terminal voltage drops below 11.9V, the battery will be automatically disconnected. Essential for boats, camping, caravans, RVs, 4WD, solar power systems etc.

- High cranking capacity - 800A
- High input/output current - 200A
- Low power consumption - 15mA
- 3 year warranty
- Mounting hardware included
- Dimensions: 85(H) x 55(W) x 35(D)mm
- Note: Battery not included

MB-3678

$99.95

Micro Blade Fuses - 10 Pack

Micro-blade fuses to suit newer model cars. The pack contains one each of 5, 7.5, 25, 30A and two each of 10, 15, 20A.

SF-2146

$9.95

Switchmode Dual Stage Lead-Acid Battery Chargers

Fully automatic switchmode battery chargers that will efficiently charge high capacity sealed and unsealed lead acid batteries then properly maintain them. Just connect and forget.

12V @ 6A
MB-3610 WAS $89.95
$64.95 SAVE $25

24V @ 6A
MB-3614 WAS $109.00
$79.00 SAVE $30

1 Watt LED Torch with In-built Car Charger Plug

Low battery? No worries, this super-bright 1 watt LED torch conveniently recharges in your car's cigarette lighter socket. With a robust aluminium alloy housing it can take a fair amount of abuse and still shine as brightly as the day you bought it.

- Dimensions: 160(L) x 35(Dia)mm

SL-3381

$19.95

Mini LED Torches

These keyring torches contain a coloured Light Emitting Diode (LED) to produce a bright light at a touch of a button. Great for parties and discos.

- Uses 3 x 1.5V silver oxide 392 included (for replacement batteries use our SB-2502)
- Size: 45(D) x 10(W) x 10(H)mm

Available in:
Blue ST-3380 Was $4.50
Red ST-3384 Was $4.50

$1.75 ea SAVE $2.75 ea

Emergency Caution Light

Compact and visible up to 800 metres away, this super strength plastic caution light contains a strong magnet for placement on vehicles in an emergency situation. With built in IC controlled LED flash, this light has 9 user-selectable flash patterns. The standard red LED is perfect for clear weather. In foggy conditions the yellow and blue LED provide superior visibility. Perfect for cars, boats and watercraft safety.

- Requires 2 x AAA batteries

ST-3201

$19.95

Cigarette Lighter Plugs & Sockets

Car Cigarette Lighter Socket 4 Way Splitter with USB Port

This cigarette socket splitter enables you to power up to four 12VDC plug appliances at once. From our range alone you can plug in a laptop adaptor, a heated travel mug, a sine wave inverter, and a rechargeable LED torch. Plus it features a USB port to charge your iPhone® or other USB gadget. Mounting hardware included.

- 12VDC plug with 12m lead
- 4 x 12VDC socket outputs
- 1 x 5VDC 1A USB port
- 10A max

PS-2019

$19.95

Merit Plug to Cigarette Lighter Socket

Allows you to connect mobile phone chargers and other cigarette lighter plugged devices into vehicles equipped with a Merit socket.

PP-2099

$12.95

IP68 3-Core Flex Joiner

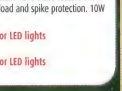
Designed to enable the joining of mains 3-core flex cables while providing a robust and waterproof connection. Includes 3-way terminal block, but will also accommodate any connector that fits within the internal dimensions of the housing.

- IP68 rated - AS/NZS3100
- Voltage rating: 250VAC
- Current rating: 16A max
- Accepts cables 6 - 10mm dia.

PS-4068

$29.95

Electronic Transformers for LED Lights



These electronic transformers are designed to be used with LED lighting products that take a 12V power source, for example our LED MR16 replacement globes, and provide the same kind of efficient power delivery and compact size as a normal electronic transformer. They deliver a constant 12VDC and feature short circuit, over temperature, over load and spike protection. 10W and 25W models available:

10W Electronic Transformer for LED lights
MP-3360 $19.95

25W Electronic Transformer for LED lights
MP-3362 $24.95

3 Stage 48V 9A Battery Charger

Suitable for golf buggies, electric wheelchairs or similar applications. It monitors and manages your charging with three different stages and will maintain the optimum charge level. Includes output cables with eye terminals to attach to your battery.

- Switchable charging modes
- LED charge status indication
- Digital Charge Display
- Short circuit, output current, polarity & thermal protection

Input: 190 - 260VAC / Output: 48VDC @ 9A max
Dimensions: 298(L) x 112(W) x 60(H)mm
3628

$499.00

Vehicle LED Daytime Running Lights

These Euro styled superbright long life LED bulbs will turn on automatically on ignition, making your car more noticeable on the road. With a lifespan of 50,000 hours, these long life and energy saving DRLs are a much better daytime alternative than using your fog lights or low beam headlights. Flush-mounted brackets are included for easy installation and directional tilt-adjustment.

- Energy efficient 12V 6.1W
- Emark 87R certificate
- Each lamp measures 190(W) x 30(H) x 43(D)mm

SL-3419

$149.00

30 Piece Tool Kit with Case

Minor DIY repairs are a breeze with this 30 piece tool kit and every DIYer should have one of these in easy reach. The tools are held securely in a zip-up case. Cutters, pliers, tape measure, sockets, screwdriver bits and more. See website for detailed contents.

- Case measures: 210(L) x 160(W) x 48(H)mm

TD-2166

$24.95

AUTO & POWER

www.jaycar.com.au

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Jaycar Electronics
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SAVE $$$ THIS MONTH ON ALL THIS SIGHT & SOUND GEAR...

HDMI In-Line Repeater/Extender

Extend the range of any HDMI device such as a monitor or TV, set-top box, DVD player, PC or gaming system up to 60 metres*.

* Note: Multiple extenders are required for cable runs above 10m to a maximum of 60 metres.

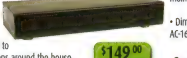
AC-1698 WAS $79.95

$24.95 SAVE $55

8 Way Speaker Selector with Impedance Matching

This speaker selector lets you simply and safely select which speakers you want to use in other locations around the house. Maintains the correct speaker load on your amplifier. Supports up to two amplifiers.

AC-1682 WAS $199.00



$149.00 SAVE $50

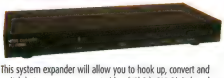
CAT 5/6 HDMI Extender

One of the disadvantages of HDMI is the limited range of cabling before extenders are needed. This extender allows you to transmit over Cat 5 or 6 cable, thereby significantly reducing cable costs if you need to transmit over some distance. Both unshielded twisted pair (UTP) and shielded twisted pair (STP) cables may be used, however shielded is recommended.

AC-1699 WAS $139.00

$110.00 SAVE $29

HDMI 3 Port Switch



This system expander will allow you to hook up, convert and switch between a component video (YPbPr), DVI-Digital, and an HDMI signal to one HDMI v1.3 output. Audio is also combined with the video signal, so you can combine stereo audio or optical digital audio with your YPbPr video source, and DVI-D can be combined with optical digital audio. Includes an IR remote control for ease of use, as well as the mains adaptor.

$129.00 SAVE $70

- Dimensions: 258(W) x 120(D) x 28(H)mm

AC-1684 WAS $199.00

Converter DVI / Digital Audio to HDMI

Combine a digital DVI video signal and a digital audio signal into a single HDMI lead with this little converter. Perfect for anyone who was thinking of hooking their media centre PC up to their home theatre system. Also provides digital audio output in both coax and optical formats. Mains adaptor included.

- Supports HD TV resolutions up to 1080p
- Supports VGA up to 1920 x 1200
- Video input: DVI-D (digital)
- HDMI v1.3 compliant
- Power: 5VDC @ 2A
- Dimensions: 125(L) x 100(W) x 25(H)mm

AC-1608 WAS $129.00

$99.00 SAVE $30

2.4GHz AV Sender/Receiver

Send audio and video all over the house wirelessly on the 2.4GHz band. Use cable TV, CD, DVD remote to change channels, volume and settings from the receiver end of this 2.4GHz system as well as sending stereo audio and video pictures around the home, shop or office, allowing you to watch video or listen to hi-fi quality stereo sound anywhere. Features a phase-locked loop (PLL) for avoiding any reception drift.

AR-1836 WAS $76.95

$49.95 SAVE $27

Spare receiver available separately -

AR-1837 WAS $44.95 NOW $29.95 SAVE $15.00

HDMI Extender

The typical maximum range of a HDMI signal is just 12m not very long if you are trying to send your high definition AV signal from one end of the lounge room to the other. This HDMI extender equalises and boosts your HDMI signal so that you can run cable up to 50m long.

- Supports up to 1080p resolution
- Compatible with VGA, SVGA, XGA, SXGA, UXGA
- Automatic equalisation up to 1.6Gbps
- HDMI v1.3 compliant
- Dimensions: 68(L) x 40(W) x 18(H)mm

AC-1697 WAS $54.95

$24.95 SAVE $30

Roadies Cable Tester

new

Simply plug the cable under test and turn the rotary switch. The LED array gives an instant go/no-go status of each conductor path in the cable. Tests Speakon, 1/4", DIN, XLR, Phono, USB and RJ45 cables.

- Requires 9V battery
- Dimensions: 190(L) x 98(W) x 35(H)mm

AA-0405 WAS $59.95

$39.95 SAVE $20

Wallplates & Sockets

new

Wallplate with VGA / 2 x RCA Sockets

VGA and 2 x RCA sockets for stereo audio and video.

PT-0478

$27.95

VGA Plug to Socket 90°

Two versions:

- Right angle adaptor - up Cat. PA-0898 $8.95
- Right angle adaptor - down Cat. PA-0899 $8.95

FROM $8.95

Brush Cable Entry Wall Plate

new

Single gang brush plate for cable entry through walls etc. Suitable for pre terminated cables going to LCD or plasma screens, and particularly suited to HDMI cables as they can't be split, spliced or field-terminated.

PS-0291

$9.95

HQ Concord HDMI Lead 0.5m

new

HDMI plug to plug. Gold plated 0.5m.

WQ-7410

$34.95

HDMI Over Cat 5/6 Extender

new

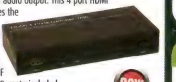
Most HDMI over Cat 5/6 extenders available use two cables for data and signal transmission. This extender only utilises one Cat 5/6 cable reducing the cable costs further on transmission over great distances. Both unshelded twisted pair (UTP) and shielded twisted pair (STP) cables may be used, however shielded is recommended.

AC-1681

$149.00

4 Port HDMI Switcher with SPDIF/Coaxial Audio Splitter

HDMI integrates audio and video signals, however it results in less than optimal audio output. This 4 port HDMI switcher separates the audio signal from the HDMI interface and transmits it to an amplifier by SPDIF or coaxial (RCA). Remote included.



new

- 4 x HDMI inputs, 1 x HDMI output with coax and SPDIF audio output
- HDMI 1.3b compliant
- Dimensions: 155(W) x 70(D) x 23(H)mm

AC-1625

$119.00

6.5mm Mono to Speakon Cable

6.5mm mono to Speakon cable for connecting small PA systems.

new

- 3m
- Super flexi cable

WA-7108

$16.95

More Super Bargains In-store!

All Savings are based on Original RRP Limited Stock on sale items

Better, More Technical Limited stock on sale items. **To order call 1800 ...**

SAVE ON PARTY GEAR

USB Guitar & Microphone Audio Interface

Simple, passive single unbalanced input audio interface for home recording or webcasting. It works on PC or Mac, requires no drivers or setup and is powered by the USB port.

- 6.5mm jack input, USB output
- Size: 100(L) x 28(Dia)mm

AM-2037 WAS $119.00

$89.00 SAVE $30

Also available:
USB Guitar/Mic/Line Audio Interface
AM-2039 Was $199.00 Now $119.00 Save $80.00

Clip-on Chromatic Tuners

You simply clip on to any part of the instrument that vibrates - then tune up as normal. The backlit display is lit red when you're out and green when you're in tune, so they're ideal for use on a dark stage or orchestra pit. Fast and accurate, suitable for electric or acoustic guitar, bass, banjo, violin, cello, double bass etc.

Clip-on Chromatic Tuner
- Frequency for A tone: 430Hz to 450Hz
- Size: 53(W) x 80(H) x 43(D)mm

AA-2041 Was $24.95

$14.95 SAVE $10

Clip-on Chromatic Tuner with Mic
Built in mic so you can tune acoustically. The head swivels through 360° for easy reading.

- Pickup: mic and clip
- Size: 53(W) x 80(H) x 43(D)mm

AA-2043 Was $34.95

$24.95 SAVE $10

50W Guitar Amplifier

With a nice clean sound, it also has switchable distortion with variable gain and level controls. Notch gain and shape control give you more flexible sound and it also has an effects loop. Good low-cost rehearsal amp for guitar or keyboards.
See website for more details.

- Bass and treble controls
- 10" speaker
- Dimensions: 410(W) x 435(H) x 220(D)mm

CS-2556 WAS $199.00

$129.00 SAVE $70

Also available: Legacy 15 Watt

DJ Single Headphone with Handle

Closed back, single cup headphone, designed especially for DJs. Keeps one hand available and frees you up from the constraints of wearing headphones. Curly cord cable terminates to 6.5mm plug.

Driver diameter: 50mm
Impedance: 48 ohms
Sensitivity: 98±3dB
Frequency response: 15Hz - 20kHz

AA-2059 WAS $69.95

$29.95 SAVE $40

Portable Combo 30W PA Amp with USB

This busker's amp has a USB port as well as the normal Mic/audio inputs, so you can plug in a memory stick and play backing or rhythm tracks in your performance. In addition, you can connect an MP3 player or CD player to the line level inputs via the RCA sockets. It has a built-in rechargeable battery that gives you 3 - 5 hours of use or it can be mains powered.

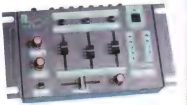
- Separate volume control on USB channel
- USB, mic & line-in inputs
- Battery or mains powered
- 3 channel mixer
- Dimensions: 245(W) x 280(H) x 245(D)mm

CS-2519 WAS $299.00

$229.00 SAVE $70

5 Input Stereo DJ/Multimedia Mixer

Small in size and price, but big on features including:



- Stereo LED VU meter
- 6.35mm headphone socket with volume control
- Microphone talk over switch
- Desk standing or console mountable
- Includes AC plugpack
- Dimensions: 330(L) x 122(W) x 39(H)mm

AM-4200 WAS $119.00

$69.00 SAVE $50

Digital Luggage Scale

Don't ruin your holiday being slugged with exorbitant excess baggage charges. Pack one of these on your next trip and avoid nasty surprises at the check-in counter.

- Requires 2 x AAA batteries
- Capacity: 40kg
- Tare and auto-off
- Backlit LCD
- Overload and low battery indication
- Size: 122(L) x 85(H) x 25(W)mm

QM-7232

$19.95

LED Wall Clock with Alarm & Remote

Eye-catching LED wall clock with brilliant bright blue numeric display. With easy-to-read numerals 2.5-inches tall, its fresh design will suit contemporary homes as well as modern offices, workshops, waiting rooms etc. Powered either by mains adaptor or 9V battery.

- 12/24 hour mode with alarm clock function
- Remote control included
- Mains adaptor included
- Dimensions: 310(W) x 33(D) x 164(H)mm

AR-1759

$69.95

Laser Lighting Effects

Green Laser Star Projector

This unit projects thousands of dazzling green laser star like formations to your ceiling. Comes with an integrated amplified speaker to connect your iPod and MP3s to blast your tunes through the stars. It also has colour changing LEDs which can be set to beat with the music or one of the four colours (red, green, blue and white).

- Size: 140(L) x 140(H) x 110(D)mm

SL-2931

$149.95

Solar Powered Alarm Clock with Laser Projection

A sleek matt-silver finished alarm clock with clear LCD time, calendar and temperature display. It projects the time when the alarm goes off or when the button is pressed.

- 12/24 hour time and °C/°F temperature
- 2 x AAA batteries (not included) with solar cell to prolong battery life
- Measures 165(L) x 35(W) x 110(H)mm

XC-0214 WAS $24.95

$19.95 SAVE $5

Wireless Mic Belt Pack - Ch A

Add lapel mics to your wireless microphone setup. The transmitter clips to your belt or fits into your pocket. Requires 9V battery. Suitable for wireless receivers AM-4077 and AM-4079.

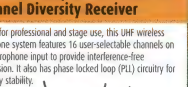
- Transmission range: 100 metres max
- Frequency: 16 Channels, 770 - 800MHz
- Dimensions: 95(H) x 62(W) x 22(D)mm

AM-4074

$129.00

Wireless Microphone PLL UHF 32 Channel Diversity Receiver

Suitable for professional and stage use, this UHF wireless microphone system features 16 user-selectable channels on each microphone input to provide interference-free transmission. It also has phase locked loop (PLL) circuitry for frequency stability.



AM-4079
WAS $499.00

$329.00 SAVE $170

Limited stock on sale items.
All Savings are based on Original RRP

SAVE ON COMPUTER PRODUCTS

Mini Stereo Resonator Speaker

This uber-cool gadget turns any flat surface into a speaker, creating high quality 360° sound.
Great for travellers. Mains plugpack included.

- Size: 47(Dia) x 44(H)mm
- Power output: 20WRMS
- Requires 8 x AA batteries for portable use

AR-1870 WAS $119.00

$45.00 SAVE $74

Infrared Digital Pen and Notetaker

Just clip to any A4 sheet of paper, start writing or drawing and everything you enter will be captured electronically. Two modes of operation: Mobile mode allows you to take and store notes (up to 100 A4 pages) while away from your computer in meetings, lectures or conferences or online mode, where you use it like a tablet PC connected to your computers USB port. Simple and intuitive to use: like putting pen to paper. Software included.

- Rechargeable battery on receiver unit
- Battery status indicator
- Standard off-the-shelf ink refills

XC-0355 WAS $179.00

$89.00 SAVE $90

2.4GHz Dipole Networking Antenna 9dB

Want to get a longer range in your wireless network? This antenna is specifically designed for 2.4GHz applications and 802.11 wireless networking. This rubber antenna is a dipole design and features a detachable base. Supplied with a 1.5 metre lead terminated to a reverse SMA connector.

- Polarisation: Vertical
- Length: 400mm

AR-3279 WAS $39.95

$24.95 SAVE $15

Active 2 Way Standing Speakers

Blow your budget on this!

These speakers are a great way to project sound from your PC, iPod®, MP3 player or mobile phone. Easily accessible volume and treble controls and simple plug and play functionality make these speakers an ideal and affordable audio solution.

- Dimensions: 235(H) x 74(W) x 54(D)mm

XC-5181

$24.95

19" Rack Mount Enclosures & Accessories

Rack Mount Enclosures

Ideal for studios, PA, sound reinforcement, IT, or phone systems installations, with a size and configuration to suit any application. Coupled with our wide range of accessories and options, these 19" rack cabinets offer outstanding features.

6U
Dimensions: 530(W) x 360(H) x 450(D)mm
HB-5170 $199.00

9U
Dimensions: 530(W) x 493(H) x 450(D)mm
HB-5172 $249.00

12U
Dimensions: 530(W) x 626(H) x 450(D)mm
HB-5174 $299.00

Swing Frame Rack Mount Enclosures

Swing frame enclosures allow access the rear of a rack system for maintenance or easier installation. Tempered glass doors and locking panels all round.

6U
Dimensions: 600(W) x 380(H) x 610(D)mm
HB-5180 $249.00

12U
Dimensions: 600(W) x 630(H) x 610(D)mm
HB-5182 $349.00

Rack System Accessories

A range of accessories to complete your rack system - blank panels for filling in space, vent panels and panels for fans or mic sockets, braked castors and feet for keeping it all where you want it. Panels are black powder coated steel, 1, 2 or 3 unit.

1U 12 x XLR Socket Panel
HB-5436 $12.95
3U 3 x Fan Panel
HB-5438 $34.95
Braked Castors Set of 4
HB-5470 $29.95
Adjustable Enclosure Feet Set of 4
HB-5472 $19.95

Ethernet over Power - 200Mbps

If you don't have the time for crimping cables and installing wallplates, Ethernet over the existing power cables is a great solution. The device will convert Ethernet packets from the Ethernet port to powerline communication packets (PLC packets), which run on regular home power lines, then converts them from PLC packets back to Ethernet packets. A simple way to extend speedy wired networking around the house.

- Data rate: Up to 200Mbps
- Data link protocol: HomePlug AV

YN-8350

$189.00

5.5" Graphics Tablet

Using a graphics tablet is completely natural, more comfortable and far more accurate than a mouse, with higher resolution and pressure sensitivity. The pen has user defined buttons and "hotspots" around the border of the tablet. Paint, draw, write or touch up. Absolutely essential tool for graphics designers, photographers or other creatives.

- Battery and software included
- Windows 2000, XP, Vista or Mac
- Dimensions: 205(W) x 190(H)mm

XC-0356

$69.95

USB 3.0 ACCESSORIES

ExpressCard with 2 x USB 3.0 Ports

Achieve transfer speeds of up to 2.5Gbps with this ExpressCard to 2 x USB 3.0 port adaptor for your laptop. Though unable to reach the maximum theoretical speed of USB 3.0 (4.8Gbps) due to ExpressCard bandwidth limitations it is still more than triple the speed of USB 2.0. This is more than enough for a significant reduction in transfer times. Compatible with XP, Vista and 7 (32-bit and 64-bit)

XC-4141

$79.95

PCI-E USB 3.0 Interface Card

Slot this PCI-Express card into your motherboard for 2 x USB 3.0 ports and reach speeds of up to 4.8Gbps, ten times faster than USB 2.0. Transfer times on hard drives and other storage platforms that support USB 3.0 will be significantly quicker. A cost effective upgrade for your desktop PC that will give compatibility with next-generation USB products. Compatible with Windows XP, Vista, 7 (32-bit and 64-bit)

XC-4143

$69.95

USB 3.0 to 2.5/3.5" HDD/SSD SATA Adaptor

Collected a box full of hard drives over the years? Want a simple way to access them? This adaptor is the perfect tool. Older USB 2.0 SATA adaptors are unable to extract the full 3.0Gbps transfer speed of SATA drives. This adaptor will give you the speed you need to transfer large files in little to no time (your PC must have a USB 3.0 port). Compatible with Windows 2000/XP/Vista/Win 7/MAC OS 9.X/10.X/Linux

XC-4145

$79.95

All Savings are based on Original RRP

Better, More Technical

Limited stock on sale items.

To order call 1800 022 888

JUNE CLEARANCE SALE

SAVE ON COMPUTER PRODUCTS

5 Port 100/1000 N-Way Gigabit Switch

High performance, 5 port, 10/100/1000 N-Way switch offers a cost-effective means of increasing network performance and reducing congestion. The switch achieves this by managing the transmission of data packets on the network and enables simultaneous connections to be made between several machines without cross-interference. 9VAC power pack included.

Max cable length: 100 metres
MDI/MDIX Auto Cross
Standards compliance: IEEE 802.3, IEEE 802.3u, & IEEE 802.3ab
Size: 130(W) x 103(D) x 27(H)mm
YN-8089 WAS $79.95

$59.95
SAVE $20

USB Optical Mouse with Number Keypad

Notebook computers are great when you are moving about or space is at a premium. However, the lack of a proper numeric keypad and mouse can be a real nuisance. This problem is easily fixed with this new combination USB keypad and mouse. It simply plugs into the computer's USB port and gives you a full function numeric keypad and mouse. Lead length 700mm.

Measures: 67(W) x 110(L) x 20(H)mm
XM-5138 WAS $37.95

$24.95
SAVE $13

Dual Sata HDD Dock with JBOD

Enjoy the added benefit of docking two SATA HDDs simultaneously. This unit will take two 3.5 inch or 2.5 inch SATA drives or one of each, making it ideal for backing up the contents of your PC, ghosting hard drives or batch partitioning. You can also mount drives in JBOD mode.

Features:
1 x eSATA cable
1 x USB A to B cable
Up to 480Mbps with USB 2.0
Up to 3Gbps with eSATA
Supports Win 2000/ME/XP/ Vista & Mac
XC-4694 WAS $99.00
Note: HDD not included.

$69.95
SAVE $29.05

High Quality IEEE1394 Cables 1.8m

Also known as FireWire, i.Link or Lynx cables, IEEE1394 is commonly used in digital audio/video and automotive applications. This range of high quality IEEE1394 cables boast 24K gold plated connectors, 99.9% oxygen free copper conductors and are shielded against EMI. If you require near faultless data streams these cables are hard to pass up.

B 9-pin to B 9-pin Cable
WC-7630 $19.95
B 9-pin to A 4-pin Cable
WC-7632 $19.95
B 9-pin to A 6-pin Cable
WC-7634 $19.95

High Quality USB 3.0 Cables - 2m

Superior quality high speed USB 3.0 cables for your nextgen USB devices. Shielded for protection against EMI. Conforms to USB 3.0 standards - 4.8Gbps.

A (male) to A (male) 2m Cable
WC-7780 $19.95
A (male) to B (male) 2m Cable
WC-7782 $19.95

Not Suitable for Windows Vista & Win 7.0

Mini PC/MP3 Speakers

Plug in your MP3 player or any other audio source and the 30mm speakers will provide more than enough volume to bop along to. Powered by batteries or 6VDC plugpack (not included).

- Requires 4 x AAA batteries
- Dimensions: 167(W) x 54(H) x 32(D)mm

XC-5177

$14.95

High Quality USB 2.0 Leads

High quality USB 2.0 leads for your PC peripherals, professional audio or camera equipment. Superior shielding protects against potential electromagnetic interferences and ensures data continuity.

A (male) to B (male)	Cat. WC-7790 $14.95
A (male) to USB-Mini B (male)	Cat. WC-7792 $14.95
A (male) to A (male)	Cat. WC-7794 $14.95
A (male) to USB-Micro B (male)	Cat. WC-7796 $14.95

HDD DOCKS

Dual HDD 2.5"/3.5" SATA Dock

We've been waiting years for an easier way to clone drives and here it is. This dual SATA dock will accept 2 x 2.5" or 2 x 3.5" (or one of each) SATA HDDs/SSDs. Just dock a drive with a complete install of an operating system, dock an empty drive and press the big red clone button. Can also be used as a regular SATA dock with mountable drives on your operating system. USB 2.0 or eSATA for connection to PC.
XC-4695 Note: HDD not included.

$89.95

USB 3.0 SATA 2.5"/3.5" HDD Dock

A 2.5"/3.5" SATA dock for USB 3.0 enabled desktop PCs and laptops. USB 3.0 boasts theoretical speeds of up to 4.8Gbps, that's ten times faster than its USB 2.0 predecessor. This dock is particularly useful for computer technicians, IT professionals and those of you who download a lot and need to swap between drives frequently.

Compatible with Windows XP/Vista/7/Mac 9.x and higher
Dimensions: 145(L) x 94(W) x 82(H)mm
XC-4696 Note: HDD not included.

$79.00

Kid's Digital Photo & Video Camera

The kids will enjoy hours of creativity with this digital photo & video camera. The robust design can withstand heavy duty play. It has a 16MB internal memory and can capture up to 120 still photos or up to 50 seconds of video.

- Requires 4 x AA batteries
- Camera driver software and USB cable included
- Windows 2000, XP & Vista compatible
- Suitable for ages 3 yrs+

QC-3188

$49.95

USB Powered Extension Lead with 4-Port Hub

Extend your printer or any other USB device as far as 10 metres away from your PC. A 4-port hub adds extra flexibility. Powered by USB from the host computer.
XC-4122

$49.95

Sabre SFX LED Sword

Challenge your friends in an intergalactic battle and bring balance to the force. Extremely light and durable, made of tough acrylic to take all the knocks of travelling around the galaxy at light speed. Sound and light effects.

Size: 710(L) x 48(Dia)mm
GF-3520

$19.95

Stocktake Clearance

Buy NOW Save $$$ Over 20 to 75% OFF ALL listed Items

Listed below are a number of discontinued (but still good) items that we can no longer afford to hold in stock. We need more space in our stores! You can get most of these items from your local store but we cannot guarantee this. Please ring your local store to check stock. At these prices we won't be able to ship from store to store.

Items will sell fast and stock is LIMITED. ACT now to avoid disappointment. Sorry NO rainchecks!

Audio/Video Products - Home, PA & Party

Product Description	Cat No	Original RRP $	Special Price $	Save $
2.4GHz Receiver with Remote Control for AR-1846	AR-1847	59.95	24.95	35.00
Audio Adaptor - 6.5mm Plug to USB	AM-2036	29.95	14.95	15.00
AV Switch - 4 Channels with Remote	AC-1587	349.00	150.00	199.00
Bluetooth Transmitter - Suits iPod®	AR-1659	69.95	24.95	45.00
Crossover Inductor 1.6mH Air Core	LF-1340	9.95	1.95	8.00
Earphones - Active Noise Cancelling with Adaptors	AR-2040	39.95	17.95	22.00
Earphones - Premium Quality	AA-2068	49.95	24.95	25.00
HDMI 2 Port Splitter with RCA Audio	AC-1653	139.00	69.00	70.00
Headphones - 12dB Noise Cancelling	AA-2058	99.95	47.95	52.00
Headphones with In-Line Volume Control	AA-2053	39.95	19.95	20.00
Headphones with Microphone for PC	AA-2028	17.95	9.95	8.00
Lead - AV 2 x RCA 1 x S-Video to SCART - 1.5m	WQ-7246	34.95	7.95	27.00
Lead - AV Plug-to-Plug 2 x RCA / 1 x S-Video - 1.5m	WQ-7254	34.95	7.95	27.00
Lead - AV SCART Plug to 6 x RCA Plugs - 1.5m	WQ-7242	34.95	14.95	20.00
Lead - AV SCART Plug to 6 x RCA RGB Plugs - 1.5m	WQ-7243	49.95	19.95	30.00
Lead - AV SCART to 2 x RCA / 1 x S-Video - 1.5m	WQ-7247	34.95	9.95	25.00
Lead - AV S-Video 4 Pin Plug to 2 x RCA plug - 1.5m	WQ-7219	29.95	6.95	23.00
Microphone Wireless with Diversity Receiver	AM-4021	259.00	120.00	140.00
Music Centre Timber Retro CD/Radio/iPod® Dock/USB	GE-4067	199.00	84.00	115.00
Music Centre Timber Retro CD/Turntable/Radio/Cassette	GE-4068	199.00	99.00	100.00
Music Centre Turntable Stylus Replacement for GE-4068	GE-4069	24.95	9.95	15.00
Party DJ MIDI Controller/Mixer - DJ Materials w/Software	AA-4250	349.00	169.00	180.00
Party DJ Rack Mount Dual MP3 Controller	AA-4492	499.00	279.00	220.00
Party Lighting - 20W Black Light Fluoro Tube	SL-3151	19.95	5.00	14.95
Party Lighting - 20W Blue Light Compact Fluoro Tube	SL-3152	19.95	5.00	14.95
Party Lighting - LED Strobe 50x WHITE 240VAC	SL-2897	79.95	23.95	56.00
Party Lighting - Mini Rotating Disco Ball With LED Spotlight	SL-2941	29.95	9.95	20.00
Party Lighting - Multi Colour DMX LED Theatre Spotlight	SL-2914	139.00	69.00	70.00
Resistant Carry case for Vinyl Records	HB-6340	79.95	35.95	44.00
Speaker - Crossover 2 Way 50WRMS 5kHz	HX-2613	10.50	4.50	6.00
Speaker - Crossover 3 Way 40WRMS 5kHz	CX-2615	16.50	6.50	10.00
Speaker - Crossover 3 Way 80WRMS 5kHz	CX-2616	24.95	9.95	15.00
Speaker - Crossover PCB 3 Way 120Rd/Octave	CX-2906	17.50	5.50	12.00
Speaker - Flat Panel Driver - 25mm 4 ohm 1W	AS-3024	6.95	2.95	4.00
Speaker - Grille Clamp Kit - 4 Pack	AK-3530	1.95	0.95	1.00
Speaker - Grille Clamp Kit - 6 Pack	AK-3531	2.95	1.50	1.45
Speaker - Rubber Surround Kit - 10"	CF-2792	29.95	9.50	20.00
Speaker - Rubber Surround Kit - 12"	CF-2793	29.95	14.95	25.00
Speaker - Rubber Surround Kit - 8"	CF-2790	34.95	14.95	20.00
Speaker Hi-Fi - 20WRMS Ribbon Tweeter - Response	CT-2032	59.95	24.95	35.00
Speaker Hi-Fi - 25mm 100 HF 150WRMS Dome Woofer	CW-2150	79.95	29.95	50.00
Speaker Hi-Fi - High-End 5" 50WRMS Kevlar Cone Driver	CW-2152	69.95	39.95	50.00
Speaker Hi-Fi - High-End 6.5" 100WRMS Kevlar Cone Driver	CW-2154	99.95	49.95	50.00
Speaker Hi-Fi - High-End 8" 150WRMS Kevlar Cone Woofer	CW-2156	159.00	79.00	80.00
Speaker Hi-Fi - In-Ceiling Outdoor 4" 20WRMS Speaker	CS-2449	99.00	39.00	60.00
Speaker Hi-Fi - In-Wall 5" 35WRMS Centre Speaker	CS-2446	99.95	44.95	55.00
Speaker Hi-Fi - In-Wall 8" 100WRMS Subwoofer	CS-2447	49.95	24.95	25.00
Speaker Hi-Fi - KSN1141A 400WRMS Piezo Horn Tweeter	CT-1912	59.95	24.95	35.00
Speaker Marine - 2 Way 4" - Response Precision	CS-2390	44.95	14.95	30.00
Speaker Marine - 2 Way 6.5" - Response Precision	CS-2392	64.95	24.95	40.00
Speaker Stereo - Active Tower 50WRMS	AR-1997	169.00	89.00	80.00
Speaker Stereo - Active Wireless Bluetooth	AR-1858	69.95	29.95	40.00
TV Antenna - Wall Brackets to Clear Eaves - 280mm	TV-1811	14.95	6.95	8.00
TV Wall Bracket - Small - 30kg Capacity	LCW-2810	42.95	24.95	18.00

IT & Comms Products

Product Description	Cat No	Original RRP $	Special Price $	Save $
Adaptor - DB9 Female to 6 Pin Female Mini DIN	PA-0947	8.95	0.65	8.30
Adaptor - DB9 Male to 6 Pin Male Mini DIN	PA-0944	8.95	0.75	8.20
Adaptor - Firewire - 6P Plug to 4P Socket	PA-0912	6.95	1.25	5.70
Adaptor - IEEE1394 Firewire - 6P Socket to 4P Plug	PA-0910	6.95	2.95	4.00
Adaptor - Null Modem	PA-0906	9.95	1.95	8.00
Adaptor - Phone 605 Plug to 2 x Phone 610 Socket	YI-6066	12.95	8.95	11.00
Antenna - 2.4GHz WiFi 10dB Gain - Wall Mount Panel	AR-3275	69.95	33.95	56.00
Antenna - 2.4GHz WiFi 14dB Gain - Ceiling Dome	AR-3277	49.95	19.95	30.00
Antenna - 3.5GHz WiFi 12dB Gain - Wall Mount Panel	AR-3274	119.95	49.95	70.00
Automatic PSP UMD Disc Cleaner	SC-5196	24.95	9.95	15.00
Bluetooth GPS receiver	XC-4895	149.00	59.00	90.00
Camera - Digital Mobile Microscope 90x Zoom	QC-3249	249.00	110.00	140.00
Camera - Compact 5MP PVR with 2" LCD	QC-3236	99.00	75.00	24.00
Camera - USB Dog-Shaped Web Cam	QC-3229	34.95	14.95	20.00
Computer - AIRAS Desktop Security Lock Rack with Fan	QC-5162	89.95	34.95	55.00
Computer - Speakers with USB MP3 Flash Player	XC-5161	89.95	34.95	55.00
Connector - Firewire 6P Socket to 6P Socket	XC-5107	9.95	4.95	5.00
Connector - UV Glow Connector Kit - Green	XC-5006	9.95	4.95	5.00
Connector - UV Glow Connector Kit - Red	XC-5008	9.95	4.95	5.00
Connector - UV Glow Connector Kit - Yellow	XC-5009	9.95	4.95	5.00
Hub - 4 Port USB In-Desk Grommet	XC-4883	24.95	9.95	15.00
Hub - Combo USB Hub/Modem/RJ45 Port	XC-4884	19.95	7.95	12.00
Lead - ATA133 IDE Internal Cable 450mm Black	PL-0970	21.95	5.95	16.00
Lead - ATA133 IDE Internal Cable 900mm Black	PL-0974	35.00	9.95	26.00
Lead - PC 1 x HDD Plug to 2 x FDD Sockets	PL-0751	6.95	1.95	5.00
Lead - USB BUS Power? - 2x USB-A to USB-B - 1.3m	WC-7158	25.95	6.95	19.00
Lightning Bolt - 400Hz N Male to N Female	AR-3276	69.95	29.95	60.00
Media Player - 500GB HDD 1080i HDMI	XC-4200	219.00	149.00	70.00
Mouse - Combo USB Wireless Mouse & Keype Phone	XM-5136	39.95	19.95	20.00
MPEG4 Player - Card Reader with Remote & PSU	XC-4866	169.00	69.00	100.00
PCI Interface Card - 2 Port SATA Controller with RAID	XC-4869	49.95	19.95	30.00
PCI Interface Card - 4 Port SATA Controller with RAID	XC-4869	69.95	29.95	40.00

IT & Comms Products (continued)

Product Description	Cat No	Original RRP $	Special Price $	Save $
RS-232 Mini Tester	PA-0886	19.95	3.95	16.00
Speaker - 2 Way PC/MP3 Active Speakers	XC-5183	119.00	49.00	70.00
Speaker - 2.1 Active Speakers PC/iPod®/MP3	XC-5185	149.95	49.95	100.00
Speaker - 5.1 PC Active Speakers 240VAC	XC-5187	79.95	29.95	50.00
Speaker - CD/MP3 Portable Speakers with Cradle	XC-5186	39.95	8.95	31.00
Storage - USB OTG Data Storage Bridge	XC-4862	59.95	19.95	40.00
Uninterruptible Power Supply - Offline 650VA 350W	MP-5200	129.00	59.00	70.00
USB Colour Changing LED Mouse	GH-1520	14.95	3.95	11.00
USB Gooseneck LED Notebook Light	SL-2801	17.95	4.95	13.00
USB Greenhouse with Software & Light	GE-4097	49.95	14.95	35.00
USB Missile Launcher with Web Cam	GE-4084	109.00	39.95	69.05

Automotive & Outdoors

Product Description	Cat No	Original RRP $	Special Price $	Save $
24VDC Portable Battle Iron	YS-2806	39.95	14.95	25.00
4VDC Portable Stove	YS-2807	49.95	19.95	30.00
Battery Charger - 4 x AAA Ni-MH to Suit DC-1010	DC-1014	14.95	2.95	12.00
BBQ Cleaning Brush with Inbuilt LED	PI-2542	29.95	9.95	20.00
BBQ Fan with AM/FM Radio and LED Torch	GG-2208	39.95	29.95	20.00
BBQ Tongs with LED Light - Stainless Steel	GG-2309	14.95	4.95	10.00
Blade Fuse - Mini 10A Red with Failure Lamp	SF-5055	1.25	0.50	0.75
Blade Fuse - Mini 20A Yellow with Failure Lamp	SF-5057	1.25	0.50	0.75
Blade Fuse - Mini 25A Clear with Failure Lamp	SF-5062	1.25	0.50	0.75
Blade Fuse - Mini 30A Green with Failure Lamp	SF-5064	1.25	0.50	0.75
Blade Fuse - Mini 5A Pink with Failure Lamp	SF-5052	1.25	0.50	0.75
Blade Fuse - Mini 5A Orange with Failure Lamp	SF-5053	1.25	0.50	0.75
Blade Fuse - Mini 7.5A Brown with Failure Lamp	SF-5054	1.25	0.40	0.85
Blade Fuse - Standard 20A Yellow with Failure Lamp	SF-5010	0.90	0.40	0.50
Blade Fuse - Standard 3A Pink with Failure Lamp	SF-5000	1.00	0.40	0.60
Blade Fuse - Standard 7.5A Brown with Failure Lamp	SF-5004	1.00	0.40	0.60
Capacitor - 2 Farad with Voltage LED Display	RU-6751	169.00	89.00	80.00
Car - In-Dash 7" LCD with Remote	QM-3782	269.00	129.00	140.00
Car - Reversing Kit with PRS Wireless Camera	QC-3725	249.00	129.00	120.00
Car Alarm - 2 Way Paging with Rechargeable Remote	LA-9018	329.00	179.00	150.00
Car Audio - 12" Subwoofer - Response Precision	CS-2352	219.00	99.00	120.00
Car Audio - 12" Subwoofer - Response Precision	CS-2354	249.00	119.00	130.00
Car Audio - 6.5" Split Grill Cover - Venom	CS-2388	69.95	29.95	40.00
Car Audio - 6.5" Split System - Response Precision	CS-2336	299.00	119.00	180.00
Car Audio - Amplifier 2 x 80WRMS - Response	AA-0420	149.00	69.00	80.00
Car Audio - FM Stereo Transmitter - Suits iPod®	AR-3112	49.95	22.95	27.00
Car Audio - Low Profile 10" Subwoofer - Venom	CS-2356	99.00	39.00	60.00
Car Audio - Low Profile 12" Subwoofer - Venom	CS-2358	119.00	49.00	70.00
Car Audio - OFC RCA Car Audio Lead - 0.5m	WA-1058	12.95	1.95	11.00
Car Charger 4 x AA AA-NiMH to Suit DC-1010	DC-1016	14.95	2.95	12.00
Eastbourn Combo Lock with LED Torch	GH-1112	9.95	2.00	7.95
Dynamo 5-in-1 Power Bank with Radio Light & Siren	SI-3370	59.95	24.95	35.00
Headset 6 Mic with Vox to Suit DC-1010	SI-1017	14.95	8.00	6.00
In-Car Media Player with USB & SD Ports	AR-1867	109.00	49.00	60.00
Key Chain Anti-Static Detector	GH-2004	9.95	2.95	7.00
Light - Rechargeable LED Outdoor Umbrella Light	SI-3290	24.95	9.95	15.00
Light - Solar Powered Pool Light	SI-3120	19.95	5.95	14.00
Light - Solar Powered Pool - White	SI-3121	19.95	5.95	14.00
Lighting - Bayonet Globe 12V 15W Automotive Style	SL-2721	1.65	0.50	1.15
Lighting - Bayonet Globe 24V 21W Automotive Style	SL-2719	1.65	0.50	1.15
Li-Ion Battery (Spare) to suit DC-1094	DC-1095	39.95	19.95	20.00
Pest Vacuum Cleaner - Rechargeable Long-Reach	DH-1392	59.95	29.95	30.00
Power Window Closer - 2 Door	LR-8851	59.95	24.95	35.00
Power Window Closer - 4 Door	LR-8856	69.95	34.95	35.00
Speaker - Steel Protection Grilles - 10"	AK-3522	9.95	4.95	5.00
Speaker - Steel Protection Grilles - 12"	AK-3524	11.95	5.95	6.00
Speaker - Steel Protection Grilles - 8"	AK-3520	9.95	4.95	5.00
Torch - CREE LED Weatherproof Head Torch	ST-3294	58.95	29.95	29.00
Torch - Rechargeable LED 1000 Lumens (x 4)	ST-3371	199.00	99.00	100.00
Wireless Brake Light for Motorcycle Helmets	ST-3186	49.95	16.95	33.00

Power Products

Product Description	Cat No	Original RRP $	Special Price $	Save $
Battery - 70 Amp Dual Battery Power Selector	MB-3672	99.95	59.95	40.00
Battery - 9V Zinc Chloride Promo	SB-2329	2.60	0.75	1.85
Battery - AA Zinc Chloride 2 Pack Promo	SB-2336	1.75	0.75	1.00
Battery - AAA Zinc Chloride 2 Pack Promo	SB-2328	2.75	0.60	1.00
Battery - Li-Po 3.7V 1600mAh for iPod® 1st & 2nd Gen	SB-2570	23.95	9.95	14.00
Battery - Li-Po 3.7V 250mAh for iPod® Shuffle 1st Gen	SB-2572	12.95	4.95	14.00
Battery - Lithium Button 3V CR927	SB-2528	3.35	0.60	2.75
Battery - Ni-Cd 3.6V 300mAh for Telephones	SB-2471	16.95	7.95	9.00
Battery - Ni-MH PC Backup 3.6V 400mAh - Varta	SB-1606	14.95	5.45	9.50
Battery Charger - 4 x AA/AAA Ni-MH	MB-3547	59.95	24.95	35.00
Charger for 12VDC-240VAC 300mA	MB-3545	29.95	14.95	15.00
Junction Box for Solar Installations- IP65 Rated	ZM-9090	39.95	19.95	20.00
Lighting - Mains Dimmer with Panel 240V 400VA	PS-4082	29.95	14.95	15.00
Playpack Switchmode - 6VDC 1.66A 2.5mm Plug	MP-3232	23.95	9.95	14.00
PSU for Luxeon LED - 6 x 3W 20VDC 700mA	MP-3278	33.95	14.95	19.00
RF Remote Controlled Receiver 240V for MS-6134	MS-6138	29.95	14.95	15.00
Transformer 240VAC - 15-30V 2A 60VA Multi-Tapped	MM-2009	27.95	14.95	13.00
Transformer 240VAC - 6-3-15V 1A 15VA Multi-Tapped	MM-2003	10.95	5.95	5.00
Transformer Toroidal 12-0-12 70VA	MT-2040	29.95	14.95	15.00
Transformer Toroidal 6-0-6 3.2VA	MT-2030	21.95	9.95	12.00
Transformer Toroidal 6-0-6 7VA	MT-2036	24.95	9.95	15.00
Transformer Toroidal 9-0-9 7VA	MT-2038	24.95	9.95	15.00

Be sure to check out the full range of Clearance lines in-store or on the Web. Many items only have one or two units in a couple of stores and you can get a fantastic bargain if you ask.
Off Original RRP. Limited stock, no rainchecks, may not be available at all stores - call your local store to check stock details. Valid till 23rd June 2010 or while stocks last!

CLEARANCE PRODUCTS

All Savings are based on Original RRP Limited Stock on sale items

Better, More Technical

Limited stock on sale items.

To order call 1800 022 888

Stocktake Clearance Sale

SALE

SALE

Security & Surveillance Products

Product Description	Cat No	Original RRP $	Special Price $	Save $
Alarm - Economy 6 Zone Wireless Alarm System	LA-5135	169.00	99.00	70.00
Alarm PIR - Curtain Lens for PIR Sensors LA-5025/30	LA-5032	5.60	1.95	3.65
Alarm Receiver - 2 Wire IR for LA-5477	LA-5478	29.95	19.95	10.00
Alarm RF Remote control to suit LA-5050	LA-5053	29.95	19.95	10.00
Alarm PIR Wireless Converter Kit with Remote	LA-5050	149.00	79.00	70.00
Balun - RGB Cat-5 Video	QC-3429	79.95	26.95	53.00
Balun - S-Video Cat-5	QC-3423	49.95	19.95	30.00
Camera - 2.4GHz CMOS Day/Night to Suit QC-3625	QC-3626	299.00	95.00	204.00
Camera - 2.4GHz Colour CMOS with Sound	QC-3595	169.00	69.00	100.00
Camera - 2.4GHz Mini Colour CMOS Kit	QC-3569	199.00	79.00	120.00
Camera - 2.4GHz Transmitter with BNC Connector	QC-3594	69.95	29.95	40.00
Camera - 2.4GHz Wireless AV Modules - Transmitter	QC-3596	79.95	29.95	50.00
Camera - 2.4GHz Wireless Baby Monitor	QC-3258	169.00	84.00	85.00
Camera - 5.8GHz Outdoor Colour CMOS Day/Night	QC-3257	169.00	69.00	100.00
Camera - ABS Outdoor Housing	QC-3385	59.95	29.95	30.00
Camera - CCD B&W Dome 380TVL	QC-3472	89.00	29.95	59.05
Camera - CMOS Colour 420TVL Day/Night Wireless 4 Ch	QC-3565	299.00	199.00	100.00
Camera - CCD Colour Dome 480TVL Pan/Tilt/Zoom	QC-3500	649.00	399.00	250.00
Camera - CCD Lead - 4 Pin PCB Plug to Bare Ends	QC-3416	4.25	0.75	3.50
Camera - CMOS Gooseneck Colour Inspection	QC-3389	199.00	79.00	120.00
Camera - CMOS IR Bullet with Lead	QC-3096	99.00	39.00	60.00
Camera - CMOS Pan-Till Night Vision with Portable LCD	QC-3279	399.00	199.00	200.00
Camera - IP MPEG4 Cam with 8 x IR LEDs	QC-3396	249.00	119.00	130.00
Camera - IP MPEG4 Cam with 8 x IR LEDs - Wireless	QC-3398	349.00	159.00	190.00
Camera - Pro CCD B&W 380TVL Day/Night	QC-3310	109.00	49.00	60.00
Camera - Pro CCD Colour 380TVL Day/Night	QC-3300	199.00	99.00	100.00
Camera - Pro CCD Colour 380TVL Day/Night 35m Range	QC-3378	399.00	179.00	220.00
DVR - 250GB Portable 4 Channel 12-CAVDVR	QC-3693	699.00	699.00	700.00
Remote - Spare to suit LA-4562	LA-4563	24.95	9.95	15.00
RFID Keypad Access Controller	LA-5123	169.00	64.00	105.00
RFID Tag - Mifare (MIFARE) to suit AA-0210	AA-0211	16.50	9.00	7.50
Siren/Strobe Wireless with Solar Charger	LA-5307	199.00	99.00	100.00
Switch Wireless Reed to suit LA-5062	LA-5062	39.95	19.95	20.00
Transmitter - Long Range Video 1.5km	QC-3425	179.00	69.00	110.00

Hardcore Electronic Products

Product Description	Cat No	Original RRP $	Special Price $	Save $
Adhesive - 25ml Metal Epoxy	NA-1516	5.95	1.95	4.00
Adhesive - FIX-LOCK Anaerobic Adhesive 7G	NA-1502	7.95	2.95	5.00
Book - "308 Circuits"	BM-2472	34.95	16.95	18.00
Capacitor - Ceramic 2U 250VDC (27mm) 10 Pack	RC-3178	7.40	1.40	6.00
Capacitor - MKT 1NB 100VDC (5mm)	RM-7018	0.25	0.08	0.17
Capacitor - MKT 27N 100VDC (5mm)	RM-7065	0.25	0.08	0.17
Capacitor - MKT 5N6 63VDC	RM-7050	0.25	0.08	0.17
Capacitor - MKT 8N2 100VDC (5mm)	RM-7060	0.25	0.08	0.17
Capacitor - SMD Tantalum 220N 35V 10 Pack	RZ-6522	9.95	1.95	8.00
Capacitor - SMD Tantalum 330N 35V 10 Pack	RZ-6524	9.95	1.95	8.00
Capacitor - SMD Tantalum 4U7 35V 10 Pack	RZ-6532	7.95	1.95	12.00
Circuit Breaker - Dual 60 Amp with Voltage Display	SZ-6004	55.00	19.00	36.00
Connector - 4.5mm Stereo SMD Socket TG Pack	PP-0140	17.95	5.95	12.00
Connector - BNC Line Plug for Digital Coax Gold Plated	PP-0654	6.70	1.95	4.75
Connector - XLR 4 Pin Female Amphenol Mount (Lock)	PP-1046	16.95	5.95	11.00
Connector - XLR 4 Pin Male Amphenol Mount - Silver	PP-1044	11.95	3.95	8.00
Connector - XLR 5 Pin Female Amphenol Mount (Lock)	PP-1076	24.95	7.95	17.00
Connector - XLR 5 Pin Female Amphenol Plug	PP-1074	19.95	7.95	12.00
Connector - XLR 5 Pin Female Cannon-Type Mount	PP-1079	9.50	1.00	8.50
Connector - XLR 5 Pin Male Amphenol Mount - Silver	PP-1072	17.95	5.95	12.00
Connector - XLR 5 Pin Male Amphenol Plug - Silver/Black	PP-1070	14.95	4.95	10.00
Connector - XLR 5 Pin Male Cannon-Type Mount - Black	PP-1078	2.95	0.50	2.45
Crimping Tool - 3-in-1 Pin Waterproof Connector	TH-1800	79.95	39.95	40.00
Dremel Bradawl Refill to suit NS-3040/42	NS-3043	19.95	9.95	10.00
Drill Bit - HSS Engineers Grade 1/4"	QT-2730	1.15	0.45	0.70
Drill Bit - HSS Engineers Grade 1/4"	TD-2718	2.75	1.40	1.35
Drill Bit - HSS Engineers Grade 11/32"	TD-2776	7.95	2.95	5.00
Drill Bit - HSS Engineers Grade 12.5mm	TD-2780	11.50	4.95	6.55
Drill Bit - HSS Engineers Grade 3/16"	TD-2712	1.75	0.75	1.00
Drill Bit - HSS Engineers Grade 3/32"	TD-2724	2.45	1.40	1.05
Drill Bit - HSS Engineers Grade 5.0mm	TD-2764	2.65	1.30	1.35
Drill Bit - HSS Engineers Grade 5/32"	TD-2709	1.75	0.75	1.00
Drill Bit - HSS Engineers Grade 6.0mm	TD-2766	2.75	1.40	1.35
Drill Bit - HSS Engineers Grade 7/16"	TD-2727	7.95	1.40	6.55
Drill Bit - HSS Engineers Grade 7/32"	TD-2715	2.45	1.40	1.05
Drill Bit - HSS Engineers Grade 8.0mm	TD-2768	4.25	1.95	2.40
Drill - Command Control Dresden 2NH09CE	ZK-6827	26.00	9.95	18.05
Kabelflag Cable Identifiers	HP-1242	11.95	7.95	4.00
LCD Display Panel - 2 Digit 12.7mm	HP-5314	6.95	3.95	3.00
LCD Display Panel -2 Line 16 Character Backlit	QP-5519	29.95	9.95	20.00
LED - 1W Luxeon Star Module Amber	QA-0401	14.95	11.95	3.00
LED - 1W Luxeon Star Module Green	QA-0402	16.95	11.95	5.00
LED - 1W Luxeon Star Module Red	QA-0400	14.95	11.95	3.00
LED - 1W Luxeon Star Module Royal Blue	QA-0406	16.95	11.95	5.00
LED - 1W Luxeon Star Module White	QA-0404	16.95	11.95	5.00
LED - 1W Luxeon Star Module White Side Emitter	QA-0407	17.95	10.95	7.00
LED - 1W Module Blue	QD-0414	12.95	4.95	8.00
LED - 1W Module Red	QD-0410	10.95	4.95	6.00
LED - 1W Super Bright Star Module - Blue	QD-0506	12.95	5.95	7.00
LED - 1W Super Bright Star Module - Red	QD-0500	12.95	5.95	7.00
LED - 1W Super Bright Star Module - Warm White	QD-0510	12.95	5.95	7.00
LED - 3mm Green 350mcd	QD-1755	0.81	0.12	0.69
LED - 3mm Yellow 5-15mcd	QD-1750	0.25	0.04	0.21
LED - 5W Luxeon Star Module Amber	QD-0434	29.95	14.95	15.00
LED - 5W Luxeon Star Module Blue	QD-0436	29.95	14.95	15.00
LED - 5W Luxeon Star Module Green	QD-0435	29.95	14.95	15.00
LED - 5W Luxeon Star Module Red	QD-0432	29.95	14.95	15.00
LED - 5W Luxeon Star Module White Side Emitter	QD-0439	29.95	14.95	15.00

Hardcore Electronic Products (continued)

Product Description	Cat No	Original RRP $	Special Price $	Save $
LED - 5W Super Bright Star Module - Blue	QD-0526	19.95	11.95	8.00
LED - 5W Super Bright Star Module - Red	QD-0524	19.95	11.95	8.00
LED - 5W Super Bright Star Module - Warm White	QD-0530	19.95	9.95	11.00
LED - 5W Super Bright Star Module - White	QD-0528	19.95	11.95	8.00
LED - 5mm Green 6000mcd	QD-1779	5.95	1.80	4.15
LED - Narrow Beam Lens to Suit Luxeon LED	QD-2427	4.95	4.50	0.45
LED - Pink SMD LED to Suit Nokia + 6 Pack	QD-2022	24.95	4.95	20.00
LED - Wide Beam Lens to Suit Luxeon LED	QD-0420	9.95	5.95	4.00
Lighting - 12V Bayonet LED Globe 6 x White	QD-0300	29.95	5.95	19.00
Lighting - 12V Mini Edison LED Globe 6 x White	QD-0300	24.95	5.95	19.00
Lighting - 12VDC 15W Mini LED Spot Lamp 2 x Yellow	QD-0424	29.95	14.95	15.00
Lighting - 12VDC 16W 20 Pcl. Round Ceiling Light	ST-3009	59.95	29.95	30.00
Lighting - MR16 24V 50W Halogen Lamp	SL-2773	6.95	1.00	6.00
Lighting - Reflector Cups to Suit SL-2810 - 20 Pack	SL-2816	9.95	4.95	5.00
Motor - Fixed Gearbox with Motor 1.5-3VDC 6650RPM	YG-2726	9.95	4.95	5.00
Motor - High Speed Gearbox/Motor Set - Tamiya	YG-2746	29.95	14.95	15.00
Proton Exchange Membrane (PEM) Fuel Cell - 600mW	ZM-9082	149.95	44.95	105.00
Proton Exchange Membrane (PEM) Fuel Cell 300mW	ZM-9080	99.00	49.00	50.00
Ratchet Set - 23 Piece	TD-2029	34.95	19.95	15.00
Screwdriver 3.6V Cordless with Pivot Handle	TD-2495	13.95	5.95	8.00
Screwdriver Set 5 x 125mm Marine Grade	TD-2344	5.95	4.50	1.45
Screwdriver Phillips #2 x 100mm Marine Grade	TD-2352	5.95	1.95	4.00
Socket Metal Screws - 175 Assorted	WP-0030	24.95	4.95	20.00
Single Stage Classic Style Universal Joint (Female) 6mm	YG-2936	34.95	24.95	10.00
Smart Card - Emerald Water Card PIC16F628 + 24LC64	CZ-8620	14.95	7.45	7.50
Spare 20mm Tip to Suit TS-1700 - 2 Pack	TS-1704	24.95	6.95	18.00
Spare 2mm Tip to Suit TS-1700 - 2 Pack	TS-1701	19.95	4.95	15.00
Switch 16 - 6 Way SPST	SM-1606	9.95	6.00	1.50
Switch Keypad - SPDT with Green LED	SP-0776	2.95	1.45	1.50
Switch Keypad - SPDT with Red LED	SP-0775	2.95	1.45	1.50
Switch Keypad - SPDT with Yellow LED	SP-0778	2.95	1.45	1.50
Switch Rocker - Mini Illuminated Blue DPST 240V 6A	SK-0988	8.95	4.95	3.50
Switch Rocker - Mini Illuminated Green DPST 240V 6A	SK-0989	8.95	4.95	3.50
Switch Rocker - Mini Illuminated Red SPST 240V 6A	SK-0985	3.95	1.95	2.00
Switch Tactile - PCB SPST with Blue LED	SP-0617	4.95	2.95	2.00
Switch Tactile - PCB SPST with Green LED	SP-0616	4.45	2.00	2.45
Switch Tactile - PCB SPST with Red LED	SP-0615	2.95	2.00	0.95
Tape - PVC Insulation Tape 18mm x 20m Roll Grey	NM-2805	2.25	1.20	1.05
Tool - Spare Battery to TD-2495	TD-2496	24.95	7.95	17.00
Trimpot - Vertical Mini 100K ohms (10mm)	RT-4043	0.40	0.10	0.30
Trimpot - Vertical Mini 2K ohms (10mm)	RT-4035	0.40	0.08	0.32
UDV Multimedia Low Voltage Cable Tester	QP-2256	199.00	104.00	104.00
Wrench Adjustable 8"	TH-2312	14.95	4.95	10.00

General Consumer Products

Product Description	Cat No	Original RRP $	Special Price $	Save $
Artist's Painting Set	GH-1934	29.95	9.95	20.00
Clock - LCD with Bracket - 19mm	XC-0220	19.95	7.95	12.00
Clock Alarm - LED Sunrise Simulation	AR-1787	79.95	19.95	60.00
Clock Alarm - Military Helicopter	AR-1788	49.95	12.95	37.00
Clock Alarm - Talking Function and Night Light	XC-0142	14.95	5.95	9.00
Clock Alarm - Water Powered (Large)	AR-1781	24.95	11.95	13.00
Desktop Australian Flag with Metal Stand	GH-1945	14.95	4.95	10.00
Digital Photo Frame 7.5" with Clock & Calendar	QM-3778	39.95	19.95	20.00
Digital Photo Frame 10.4" - Bluetooth Enabled	QM-3779	249.00	174.00	175.00
Digital Photo Frame 7" Slimline Design	QM-3777	99.00	59.00	40.00
Glowstick - 6 Inches Blue	ST-3161	2.95	0.80	2.15
Glowstick - 6 Inches Pink	ST-3164	2.95	0.80	2.15
Glowstick - 6 Inches Red	ST-3162	2.95	0.80	2.15
Glowstick - 6 Inches White	ST-3163	2.95	0.80	2.15
Glowstick - 6 Inches Yellow	ST-3165	2.95	0.80	2.15
Golf Green Novelty Ashtray	TD-2000	24.95	7.95	17.00
Kit - 301 Piece Solar Powered Construction Set	KJ-8905	34.95	9.95	25.00
Kit - Historical Construction Set - Windmill	KJ-8900	14.95	5.95	9.00
Kit - Mini Experiment - Film Viewer with Periscope	KJ-8886	9.95	2.00	7.95
Kit - Mini Experiment - Flashing LED	KJ-8842	9.95	2.00	7.95
Kit - Mini Experiment - Water Filter Column	KJ-8894	9.95	2.00	7.95
Kit - Solar Hydrogen Generation	KT2524	99.95	49.95	50.00
Kit - Solar Puzzle LED Digital Clock	KJ-8910	9.95	2.00	25.00
Kitchen Sprzuiter Kit - Whisk/Herbs/Sprouts	GH-1254	39.95	12.95	27.00
Laser Pointer - 3-in-1 Keyring with UV Light & LED Torch	ST-3106	14.95	4.95	10.00
Lighting - LED Desklamp with Pivot Head	ST-3129	24.95	9.95	15.00
Lighting - Solar Waterproof Electronic Candles 5 Pack	ST-3055	49.95	14.95	35.00
Novelty Arcade Coin Pusher	GT-3138	49.95	9.95	40.00
Novelty Bingo Game Caller	GT-3142	49.95	9.95	40.00
Novelty Chess-a-Hubby	GT-3020	49.95	9.95	40.00
Novelty Remote Command-A-Man	GT-3170	9.95	1.00	8.95
Novelty Remote Command-A-Woman	GT-3172	9.95	1.00	8.95
Novelty Solar Glass with Flashing LED	GH-1150	9.95	0.60	9.35
Pen - LED Blue Glowlight Pen	TC-3066	9.95	1.95	7.75
Pink Novelty Spider Catcher (4 x A)	GH-1870	14.95	4.95	10.00
Pink Rhinestone Tape Dispensor	GH-1896	24.95	14.95	10.00
Pink Rhinestone USB Optical Mouse	GH-1899	69.95	39.95	30.00
Prenatal Heart Listening Device with Speakers	GH-1910	49.95	22.95	27.00
Remote Control - Mini Mosquito with LEDS	GH-1920	29.95	9.95	20.00
Rubbish Bin - Automatic Opening Sensor - 23 Litres	GG-2316	49.95	24.95	25.00
Scale - Kitchen Bench 2kg	GH-2794	29.95	19.95	20.00
Scale - Pocket 200g	GM-7241	99.95	39.95	60.00
Shocking Novelty - Alarm Clock (2 x AAA)	GH-1109	19.95	7.95	12.00
Shocking Novelty - Number Guessing Game (3 x AAA)	GH-1124	24.95	9.95	15.00
Talking Translator - 15 Languages	XC-0779	69.95	29.95	40.00
Temperature / Soil Moisture Sensor for QM-7206	QM-7207	29.95	13.95	16.00
Travel Shaver Kit - Rechargeable	GH-1516	29.95	5.95	24.00
White/Silver Rhinestone Stapler	GH-1895	19.95	7.95	12.00
Wine Cooler - 6 Bottle 16L Capacity - 240VAC	GH-3372	199.00	85.00	114.00

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Wireless Cabinet LED Lights

Small in size and wire-free , these LEDs light up a great surface area. Easy to fit and install they each have a sensor and will only light up when the door is open and switches off once the door is closed using minimal energy (3 x AAA required). Great for use in cabinets, sliding doors, lockers, safes etc.
Two models available:

4 LED
• Dimensions: 70(H) x 45(W) x 19(D)mm
Cat. ST-3191 WAS $14.95
NOW $11.95 SAVE $3.00

7 LED
• Rotating light head
• Four stage on/off switch
• Dimensions: 115(H) x 45(W) x 28(D)mm
Cat. ST-3192 WAS $24.95
NOW $19.95 SAVE $5.00

Horizontal Mini LED Light

Pre wired in a sleek and compact design, this a perfect mini LED light for illuminating harsh areas. Using new advanced lens technology the LEDs increase light output for optimal lighting with minimal power. White horizontal and vertical mounts included in the kit.

• 12VDC
• Dimensions: 39(W) x 12.7(H) x 12.7(D)mm
ST-3193 WAS $12.95

$9.95
SAVE $3

3 Piece LED Puck Light Kit

new

3 x 1W puck lights that can be surface mounted or recessed to fit with your décor. They're powered by a single plugpack with a distribution block on a 2 metre cable. Each light has its own 600mm cable, so you can easily install them yourself.

• Fashionable cool white colour
• More than 30,000 hours life
• Power supply 12VDC 1A
• Light size: 72(Dia) x 28(H)mm
ST-3894

$149.00

IP67 LED Landscape Spotlights

IP67 rated for complete protection against the weather and can even be mounted in a water feature or rock pool. Being LED, they use very little power and will last for thousands of hours. Each can be mounted on a surface or on the stout spike and thrust into the ground in a convenient location. Each has a 5m length of cable and extension cables are available. 1W or 3W types.

new

• Provides natural-looking light
• Energy efficient
• Equivalent to a 50 watt halogen

1W
Cat. SL-2755 $29.95
3 x 1W
Cat. SL-2756 $59.95
Power Supply 12VAC 12W
Cat. SL-2757 $24.95
Power Supply 12VAC 24W
Cat. SL-2754 $39.95
Extension Cable 5m Screw Lock
Cat. SL-2759 $19.95

CREE® LED Powered Torches

This range of new CREE® LED torches are all encased in rugged aircraft-grade aluminium to withstand the rigours of constant use.

new

90 Lumen
• Dimensions: 95(L) x 20.5(W) x 20.5(D)mm
• Requires 1 x AA battery
Cat. ST-3452 $24.95

170 Lumen
• Dimensions: 147(L) x 20.5(W) x 20.5(D)mm
• Requires 2 x AA batteries
Cat. ST-3454 $29.95

190 Lumens
• Dimensions: 73(H) x 21(W) x 21(D)mm
• Requires 1 x CR123A Li-ion battery
Cat. ST-3450 $29.95

190 Lumen with Adjustable Lens
• Adjustable beam: 5 zoom options
• Dimensions: 105(L) x 34(W) x 27.5(D)mm
• Requires 3 x AAA Batteries
Cat. ST-3456 $39.95

FROM $24.95

Keyring Keyfinder with LED Torch

Ever misplaced your keys and needed them in a hurry? This brilliant device will generate a beeping sound when it detects a whistle. It will work effectively within a 3 metre radius. Also doubles as a handy keyring torch! Batteries included.

new

• Uses 2 x LR44 batteries
• Size: 52(L) x 40(W) x 15(W)mm
XC-0351

$4.95

UHF CB Transceiver

When out in the bush and mobile phone reception fails, this advanced CB transceiver provides a vital communications link between those within your camping group as well as the outside world.

• 2W power, 10km line of sight range
• 500mW power saving mode
• 38 Channel with CTCSS
• Backlit LCD with stopwatch
• Size: 120(L) x 57(W) x 35(H)mm
DC-1047

$99.95

Personal Mini Alarm with LED Torch

new

A personal alarm made from tough ABS construction with a 120dB siren to deter thieves and attackers. To activate simply pull the rip-cord to pull out the pin. Replace the pin to deactivate the alarm. Also includes a LED light. Great for travellers.

• 105-120dB
• Practical design
• Compact size
• Includes 3 x LR44 batteries
• Dimensions: 72(L) x 31(W) x 22(H)mm
LA-5183

$9.95

Single Channel Keyfob Remote

Multi-purpose remote control keyfob for garage doors, lights, automatic gates etc. It operates in the 27MHz band on an FM signal. The built-in microcontroller uses the latest technology allowing for easy setup and installation while providing maximum security and reliability.

new

• Battery status LED
• Up to 200m range
LR-8847

$49.95

Mini Wireless Weather Centre

Keep up-to-date with current and forecasted atmospheric conditions at a glance. With two small outdoor weather sensors, it precisely measures, records and forecasts all the basic weather parameters and displays them on an LCD screen. Handy features include three forecast icons based on changing barometric pressure.

new

$99.00

• LCD screen: 135(W) x 34(D) x 140(H)mm
• Outdoor wind sensor: 110(H) x 180(D)mm
• Temp/bar/humidity sensor: 57(W) x 57(D) x 160(H)mm
XC-0349

NEW SERVICE AIDS

Lithium Grease 400g

Long-lasting heavy duty lubricant grease for bearings, sliding mechanisms, battery terminals, chains, sprockets or other moving parts. White in colour so it forms a kind of thick, milky sea in the lubricated area. Reduce friction, protects against corrosion.
NA-1015

new

$9.95

Silicone Rescue Tape

Gaffa tape on steroids. Rescue tape is a self-fusing tape made of the highest quality materials for a permanent air-tight and water-tight seal. Resists fuels, oils, acids, solvents, salt water, road salt, UV rays. It is designed for quick plumbing repairs, sealing hoses in your car/truck/boat, coating the ends of rope, wrapping tool handles, emergency o-ring seals or to insulate electrical wiring. Tightly wrap the tape for a quicker bond.
NA-2829

new

$19.95

JUNE CLEARANCE SALE

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SAVE ON SECURITY PRODUCTS

Economy four Zone Wireless Alarm

An affordable system that provides reliable protection for your home, apartment or small office. The system is simple to install and the alarm panel will detect and 'learn' which sensors have been installed. The control unit also monitors the system status and sensor battery condition to ensure system reliability. Includes control panel with keypad, a passive IR motion sensor, and a reed switch sensor for door or window protection. Wireless installation makes the system ideal for tenants. Batteries and power supply included.
LA-5134 WAS $89.95

$49.95
SAVE $40

B&W Video Door Phone

See who's at the door, or even the front gate before you let them in. This modern, slimline video intercom system will let you identify callers without them even knowing. The system consists of a black and white CMOS camera with speaker and microphone and internal monitor with handset.
QC-3602 WAS $129.00

$109.00
SAVE $20

Works with our remote door release - LA-5078 $49.95

Biometric Fingerprint ID Access Control

Control a single door or use multiple units on a site connected to a PC via an RS232, RS485 or Ethernet connection. Software included.

- Up to 500 users
- 12VDC 3A relay output
- Requires 9VDC @ 500mA
- Dimensions: 180(L) x 82(W) x 55(H)mm

$279.00
SAVE $220

LA-5121 WAS $499.00

Also available **Universal RFID/Fingerprint Access Controller** Cat. LA-5122 Was $299.00 Now $199.00 Save $100.00

DOOR STRIKES

Electromagnetic Door Locks

Compatible with any access control system, magnetic door locks meet the most rigorous building and fire safety codes. No moving parts, instantaneous release, holding force of 180kg or 280kg. They can be surface mounted or ZL and L brackets provide for installation in wood, metal or glass doors. Both operate from 12VDC and are finished in satin anodised aluminium. Suitable for in-opening or out-opening doors, mounting hardware and drilling templates included.

180kg Electromagnetic Door Lock
Size: 170(L) x 41(W) x 21(H)mm Cat. LA-5060 $79.95
ZL Bracket for LA-5060 Cat. LA-5061 $39.95
L Bracket for LA-5060 Cat. LA-5062 $24.95
280kg Electromagnetic Door Lock
Size: 250(L) x 49(W) x 25(H)mm
Cat. LA-5063 $99.00
ZL Bracket for LA-5063
Cat. LA-5064 $39.95
L Bracket for LA-5063
Cat. LA-5065 $24.95

Narrow Electric Door Strikes - 12VDC

Upgrade your conventional door locks to keyless entry electronic access. Suitable for narrower doors and are available in fail-secure or fail-safe models depending on whether your priority is internal security or exit in case of emergency. These can also be paired with one of our intercoms or video doorphones to create a convenient remote door access system. Suitable for wood, aluminium and hollow metal jambs.

Power: 12VDC, 450mA
Face plate dimensions: 160(L) x 25(W) x 28(H)mm

Fail-Secure Cat. LA-5077 $29.95
Fail-Safe Cat. LA-5079 $29.95

CCTV Power Distributor Box

Makes distributing power to multiple CCTV cameras a simple matter. Simply connect a common source up to 30VDC and distribute it to up to 9 slave devices. Screw terminal connection.

- Individually protected PTC output
- Individual status LED indicators
- 1 - 30V AC or DC input
- Dimensions: 138(L) x 65(W) x 28(H)mm

$39.95

MP-3351

Stirling Engine Kit

Made in Germany, our Stirling engine kit is beautifully engineered from stainless steel, brass and a genuine beech base. It has 2 ball bearings and should become an heirloom. It converts heat into mechanical energy by alternately compressing and expanding air. The expanding air acts on a piston to provide mechanical force: you simply heat up the air chamber, give the flywheel a whirl and away she goes.

- Recommended for ages 12+
- Adult supervision recommended
- Working speed: 2,500RPM
- Working time: Approx. 30 min
- Dimensions:156(L) x 108(W) x 70(H)mm

$299.00

YM-2921

Electronic Project Kits

Webserver In a Box Kit

Refer Silicon Chip Magazine November 2009

Host a website on a common SD/MMC card with this compact Web server In a Box (WIB). It connects to the Internet via a modem/router and features inbuilt HTTP and FTP servers, SMTP email client, dynamic DNS client, RS232 serial port along with four digital outputs and four analogue inputs. Requires a SD memory card, some SMD soldering and a 6-9VDC power adaptor.

$89.95

- Includes PCB, case and electronic components

KC-5489

Low Capacitance Adaptor for DMM Kit

Refer Silicon Chip Magazine Feb 2010

Many modern multimeters come with capacitance ranges, but they're no good for very small values. This kit is a nifty little adaptor that allows a standard digital multimeter to measure very low values of capacitance from less than one Picofarad to over 10nF. It will allow you to measure tiny capacitors or stray capacitances in switches, connectors and wiring. The kit is complete with PCB, components and case. All you'll need is a 9V battery and just about any modern DMM.

$34.95

KC-5493

High Performance 12V Stereo Amplifier Kit

Refer Silicon Chip Magazine May 2010

An ideal project for anyone wanting a compact and portable stereo amp where 12V power is available. No mains voltages, so it's safe as a schoolies project or as a beginner's first amp. Performance is excellent with 20WRMS per channel at 14.4V into 4 ohms and THD of less than 0.03%. Shortform kit only. Recommended heatsink Cat. HH-8570

- PCB: 95 x 78mm
- 12VDC

$44.95

KC-5495

New Switches - Just Arrived!

IP56 Rated Pushbutton Switches

IP65 rated for use in harsh environments. Rated for 14V 10A, with 22mm mounting hole. Only red is illuminated.

Black SPST Momentary
Cat. SP-0756 $6.95
Red SPST Momentary Illuminated
Cat. SP-0757 $8.95
Black SPST Push-On Push-Off
Cat. SP-0758 $6.95
Red SPST Push-On Push-Off Illuminated
Cat. SP-0759 $8.95

Engine Start Switch

- Keyless engine start for track or street.
- Illuminated momentary action pushbutton
- Rated for 12VDC 50A
- Mounting hole 22mm

$19.95

SP-0773

C&K Mini Toggle Switches

Quality US made with solder tags.
SPDT Cat. ST-0396 $6.45
DPDT Cat. ST-0398 $8.95

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Better, More Technical

ABS Instrument Cases with Purge Valves

new

With superb robust moulded design to rival the more expensive brands, this brand new range of quality instrument cases are our best yet. They come with all the quality inclusions such as airtight purge valves, ribbed ABS construction, stainless steel hinge pins, O-ring seals and very solid catches. The lids are lined with removable egg-shell foam and they come with pluck foam insert with an extra layer of egg-shell foam. All backed by a 3 year warranty.

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HB-6381 $69.95

MPV4
Internal: 400(W) x 322(D) x 145(H)mm
External: 410(W) x 332(D) x 155(H)mm
HB-6383 $99.95

MPV7
Internal: 480(W) x 355(D) x 180(H)mm
External: 490(W) x 365(D) x 190(H)mm
HB-6385 $129.00

MPV8 with Wheels
Internal: 512(W) x 292(D) x 180(H)mm
External: 522(W) x 302(D) x 190(H)mm
HB-6387 $189.00

How to Test Almost Everything Electronic Book

new

Everything from setting up a test and work area to using test equipment - multimeters, oscilloscopes, signal generators, signal tracers etc. It also covers testing and measurement methods, fault finding without circuit diagrams, component testing and some highly specialised measurement in applications such as audio and TV.

- Softcover 326 pages
- 190 x 130mm

BM-7200 **$42.95**

Getting Started with Ar

Arduino is an open-source development platfo
enables experimenters to configure an open hardware design for a single board microcontroller. Aimed at the first-timer, this book explains what it is and how it works, and what you can do with it. It also includes a project to build complete with how to write the code to make it work.

Softcover 118 pages. 216 x 140mm
BM-7130 **$23.95**

Super Bargain Autoranging DMM

An autoranging multimeter for checking all sorts of things!

- CAT III 600V Autoranging
- Display: 2000 count
- Auto power-off
- Max hold
- Audible Continuity
- Diode test
- Dimensions: 53(W) x 108(H) x 32(D)mm

QM-1528 WAS $24.95 **$14.95** **SAVE $10**

Practical Arduino

new

A much larger and detailed book. It takes you beyond basics quite quickly and shows you how to make up a typical application/design. Examples of typical projects, 14 in all are worked, ranging from simple to quite complex. This is a necessity as it goes to the heart of Arduino.

Softcover, 422 pages. 290 x 200mm
BM-7132 **$57.95**

SAVE ON TOOLS & DIGITAL MULTIMETERS

Cat IV Fixed Jaw Clampmeter

An ideal test instrument for electrical contractors. Compact and light with probe storage in the back for easy one-handed operation. Jaw opening is 16mm.

- Category: Cat IV 600V / Cat III 1000V
- Display: 2000 count
- Size: 190(H) x 62(W) x 42(D)mm

QM-1567 WAS $179.00 **$129.00** **SAVE $50**

Autoranging Pocket DMM

Pocket-sized DMMs have come a long way from the novelty toys that they use to be. This excellent autoranging pocket DMM is a genuine test instrument. Its compact slimline design enables single hand operation, ideal for testing in awkward situations such as roof cavities and up on ladders.

- Display: 5000 count
- Category: Cat II 600V / Cat III 300V
- Dimensions: 112(H) x 56(W) x 12(D)mm

QM-1544 WAS $59.95 **$39.95** **SAVE $20**

Trade Quality Cat IV DMM

A true RMS DMM purpose built for professional applications. With an ergonomic slimline yet robust design, it has overload protection, easy battery replacement, and comes supplied with a protective holster and test lead. A trustworthy instrument for apprentices and seasoned tradesmen alike.

- Display: 4000 count
- Category: Cat IV 600V / Cat III 1000V
- Size: 164(L) x 82(W) x 44(D)mm

QM-1623 WAS $199.00 **$129.00** **SAVE $70**

Rechargeable Solar DMM

An environmentally friendly DMM with rechargeable batteries that can be charged from the built-in solar panel, 12-36VDC or from mains power. Never have to buy batteries again.

- Category: Cat III 600V
- Display: 2000 count
- Size: 179(H) x 88(W) x 39(D)mm

QM-1546 WAS $119.00 **$99.00** **SAVE $20**

Magnetic Wrist Tray

This simple yet ingenious wrist tray will hold small steel screws, washers, nuts, split pins, or other steel items so you won't put them down and lose them.

TH-1971 WAS $14.95 **$4.95** **SAVE $10**

Rotary Tool Bit Set - 400pc

With 400 pieces, this great value kit gives you just about every rotary bit you will ever need. Sanders, grinders, drill bits, polishers plus a whole lot more. See our website for details.

- Case measures: 210(W) x 300(H) x 70(D)mm

TD-2456 WAS $39.95 **$29.95** **SAVE $10**

29 Piece Tool Kit with Torch

DIY minor repairs are a breeze with this 29 piece tool kit. All the basic essential tools, including a torch, all stored in a stylish silver case.

- Case measures: 200(L) x 145(W) x 45(H)mm

TD-2066 WAS $34.95 **$29.95** **SAVE $5**

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Arrival dates of new products in this flyer were confirmed at the time of print. Occasionally these dates change unexpectedly. Please ring your local store to check stock details. Prices valid to 23rd June 2010.
All savings are based on original RRP

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CIRCUIT NOTEBOOK

Interesting circuit ideas which we have checked but not built and tested. Contributions from readers are welcome and will be paid for at standard rates.

Float charger for NiMH cells

Although not a new device, the LM317 is still a high-performance regulator. Its output voltage is essentially immune to fluctuations in load, supply voltage and temperature and this makes it ideal as the central element in a float charger for NiMH cells. Float charging has the advantage of keeping the cells fully charged and ready to use without the potential damage of long-term trickle charging or the cost of low-discharge cells. This works because NiMH cells do not have the memory problems associated with Nicads.

The circuit is based on a conventional LM317 regulator. Resistors R2 & R3 and trimpot VR1 set the maximum output voltage to between 1.3V and 1.4V per cell. VR1 should be adjusted for a value of 1.35V per cell at the regulator outout. Resistor R2 has been fixed at 240Ω. The formula for the voltage output is:

Vout = 1.25(1 + (R3 + VR1)/R2)*

Diode D1 protects the circuit against reverse polarity of the power supply and protects the LM317 should the power be disconnected while it is still connected to a charged battery pack. Resistor R_{CL} and transistor Q1 limit the maximum current in the event of a short circuit or the connection of a severely discharged battery pack. LED2 provides an indication of voltage input to the charger.

LED1 and the 680Ω resistor provide the same function for the charger output and also provide a minimum load for the regulator when the battery pack is nearing full charge. This is necessary to keep the regulator output from drifting up and damaging the batteries.

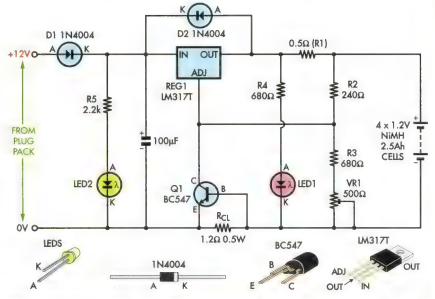

Table 1

Number of NiMH cells	Plugpack Voltage	R3	VR1	R2	R4	R5
1	6V	0Ω	100Ω	240Ω	270Ω (replace LED1 with a wire link)	820Ω
2	9V	220Ω	200Ω	240Ω	180Ω	1.5kΩ
4	12V	680Ω	500Ω	240Ω	680Ω	2.2kΩ
6	15V	1.1kΩ	500Ω	240Ω	1.2kΩ	2.7kΩ
8	18V	1.5kΩ	1kΩ	240Ω	1.8kΩ	3.3kΩ
10	20V	2kΩ	1kΩ	240Ω	2.2kΩ	3.6kΩ

Maximum current	200mA	400mA	500mA	600mA
R1	1.2Ω	0.6Ω (1.2/1.2)	0.5Ω (1//1)	0.4Ω (1.2//1.2//1.2)
R_{CL}	3.3Ω	1.5Ω	1.2Ω (0.5W)	1Ω (1W)

The circuit uses an external DC plugpack and is suitable for four NiMH cells rated at 2.5Ah. Table 1 gives alternative values for 1-10 batteries in series at peak charge currents of between 200mA to 600mA.

If you are using the specified plugpack and the TO-220 packaged LM317T, you will need a heatsink rated at 12°C/W or better for any design other than the 200mA single cell charger. A TO-3 packaged device with the correct plugpack will be OK without a heatsink for any of the 200mA configurations and up to four cells charging at 400mA.

David Eather,
Toowoomba, Qld. ($40)

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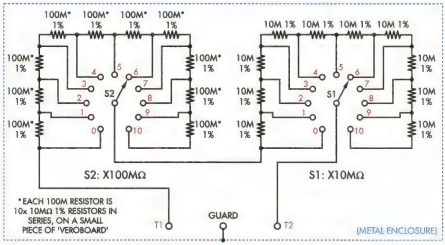


Low-cost gigaohm decade resistance box

During development of the Digital Insulation Meter described elsewhere in this issue, it was necessary to check its operation with an accurate high-resistance reference – preferably one that provided resistance values up to around 1GΩ or 1000MΩ. Since such a reference does not appear to be readily available, I decided that the only option was to build my own.

The idea was to come up with a two-decade resistance box to provide values between 0Ω and 1100MΩ (1.1GΩ) in 10MΩ steps, with a basic accuracy of 1% per step. The resulting design uses a considerable number of 10MΩ 1% metal-film resistors, mainly because this is the highest value currently available with this tolerance.

There are 110 of these resistors used in all, since each of the 100MΩ resistors used in the "x100MΩ" decade is made up using ten 10MΩ resistors in series. The resistors are currently available for around six cents each, so the total cost for the resistors is around $6.60.

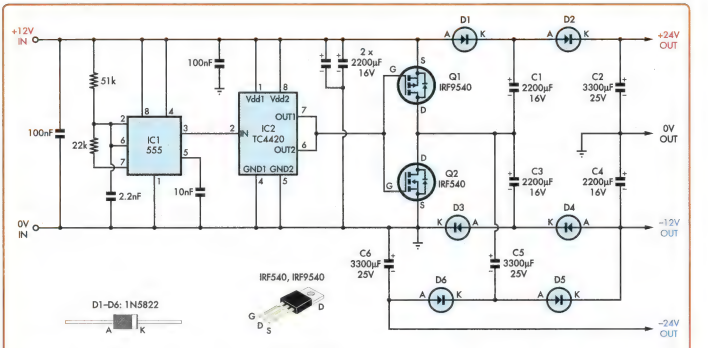
The switches used for S1 and S2 are of the standard single-pole rotary type, programmed for 11 positions. The two switches are housed in a standard 119 x 94 x 57mm diecast aluminium box, which provides both physical protection and shielding (which is quite important for making measurements on resistance values of this order). This box is currently available for about $19, so it's actually the most expensive part of the project. The only other components needed, apart from the resistors, are the two rotary switches, their knobs and three binding posts, bringing the total cost of the decade box up to around $43.

The individual 10MΩ resistors used for the "x10MΩ" decade are simply connected between the connection pins of switch S1, in daisy-chain fashion. On the other hand, the ten 10MΩ resistors used in each leg of the "x100MΩ" decade are mounted on small pieces of stripboard or Veroboard and connected in series. Each of these fabricated "100MΩ" resistors is then connected between two of the connection pins of S2 using two short leads made from hookup wire.

If you want to use this unit with the Digital Insulation Meter on the 1000V test mode, the resistors should be high-voltage types as specified in the parts list for that project.

Jim Rowe,
Silicon Chip.

This 2-decade resistance box provides values between 0Ω and 1.1GΩ in 10MΩ steps. It is built into a diecast aluminium box which provides the necessary shielding.



12V to ±24V switched capacitor supply

This circuit is able to deliver a nominal ±24V from a 12V supply. Depending on the exact components used and an adequate 12V supply, it is possible to draw up to 1.5A from each rail. The output voltages are not regulated and will be slightly less than double the input voltage.

One potential application is obtaining regulated ±15V rails from a lead-acid battery (eg, in a car), by adding 7815 and 7915 3-terminal regulators. It could also be handy if you want to generate a split supply from a switchmode plugpack. High current 12V supplies are cheaper and more plentiful than high current AC plugpacks.

Note that there will be switching noise in the output and this will be proportional to the output current drain.

The NE555 is configured as an astable oscillator running at around 6.5kHz, with a 50% duty cycle. Its square wave output drives a TC4420 high-current low-side Mosfet driver (available at **www.futurlec.com**).

Complementary Mosfets Q1 and Q2 are configured as a CMOS inverter. Their drains are joined together and to three capacitors so that they drive three charge pumps via six diodes. When the drain junction swings low, capacitor C1 charges up to 12V via diode D1. When this junction swings high again, the positive terminal of C1 is boosted to double this, ie, 24V and capacitor C2 is charged to this voltage via diode D2.

The Mosfet driver ensures that the gate capacitances of both Mosfets are charged and discharged rapidly. This is important since it minimises the amount of "shoot-through" current which flows during switching, when both Q1 and Q2 are briefly turned on simultaneously.

All the diodes specified are high current Schottky types to minimise switching and forward voltage losses. Since the frequency as shown is only 6.5kHz, standard silicon rectifiers would work but efficiency would drop and the heat output would increase.

Generating the -24V rail is a little trickier since it has to be done in two stages. Diodes D3 & D4 together with capacitors C3 & C4 first generate -12V. When the drain junction is high, C3 charges up to 12V via D3. When it goes low, the lower end of C3 swings to -12V and this charges C4 via D4. The same principle is used again, this time with -12V as the source, to generate -24V via D5, D6, C5 & C6.

As the current drain increases, the output voltages will drop. There are several factors which limit how much current you can draw from the output.

First, there is the 3A limit of each diode. Because the input current is necessarily higher than the output current, ie, the output power product (V x I) can not exceed the input power product, the current through D1 is twice that drawn from the +24V output. Similarly, the current through D3, D4 & D5 is twice that drawn from the -24V output. Therefore, larger diodes are necessary if you are to exceed the 1.5A figure.

Additionally, all the current must pass through the switched capacitors, C1 for the +24V rail and C3 & C5 for the negative rail, as well as the storage capacitor C4. In fact, C1, C3, C4 & C5 have twice the output current flow through them for the same reasons as the diodes mentioned previously. If you are going to draw a significant amount of current from the output, you must use physically large capacitors.

Ideally, use low ESR capacitors or else several in parallel, otherwise you might exceed the ripple current ratings, causing excessive internal heating and damage. The values and voltages shown are those used in the prototype but they should be considered minimums. Ensure that the ripple current ratings of the capacitors used are sufficient for your application and remember that some pass double the output current.

Nicholas Vinen,
Silicon Chip.

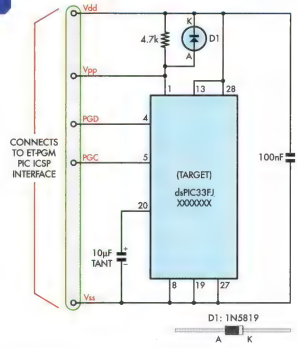
Programming adaptor for the WIB microcontroller

When I came to program the dsPIC33FJ64GP802 microcontroller used in the WIB (Webserver in a Box, SILICON CHIP, November & December 2009, January 2010), I found that my ET-PGMPIC programmer, purchased from Futurelec, does not directly support this chip. The programmer is software-compatible with Microchip's PICkit2 software and hence is also compatible with their MPLAB development suite. It incorporates several good design features such as being able to test the operation of the controller over a range of Vdd supply voltages and connects to the PC via a USB port.

The problem was solved by building an outrigger board which consists of a ZIF (zero insertion force) IC socket mounted on a piece of Veroboard together with a 6-pin header plug. The plug connects to the 6-pin ICSP header on the programmer using a 6-wire ribbon cable. The 10µF tantalum capacitor is necessary for the operation of the on-chip 3.3V to 2.5V down-converter.

Note that the programming technique is quite different to mid-range PIC16 devices in that no high programming voltage is applied to the MCLR pin (pin 1).

In theory, this adaptor board should also be able to be used with a PICkit2 programmer although this has not been tested.



Trevor Woods, Auckland, NZ. ($40)

Using the Voltage Interceptor with a frequency output air-flow meter

The Digital Fuel Adjuster featured in "Performance Electronics for Cars" and the updated Voltage Interceptor version from SILICON CHIP, December 2009, are ideal for altering the signal from MAF (Mass Air Flow) sensors which produce a voltage output. However, they do not work with air-flow sensors that produce a frequency signal.

One such sensor is the Karman Vortex. If you want to know more about this meter, point your web browser to: **http://www.wellsmfg-corp.com/pdf/Counterpoint3_3.pdf** and **www.autoshop101.com/forms/h34.pdf**

Its output is typically about 30-40Hz at idle, rising to between five and 10 times that frequency at full throttle and maximum RPM.

To use this sensor with the Digital Fuel Adjuster or the Voltage Interceptor, its frequency signal must be converted to a voltage. Then, after being processed by the Voltage Interceptor, the modified voltage output must be converted back to a frequency, suitable for the car's ECU AFM (airflow meter) input.

This add-on circuit does both conversions, as depicted in the block diagram. Conversion from the AFM frequency output to voltage utilises an LM2917 frequency-to-voltage converter (IC1). The frequency signal is applied to a filter comprising a 10kΩ resistor and 10nF capacitor. A 10kΩ resistor ties the signal to ground when there is no signal or connection. The filtered signal is connected to the non-inverting input of a Schmitt trigger at pin 1.

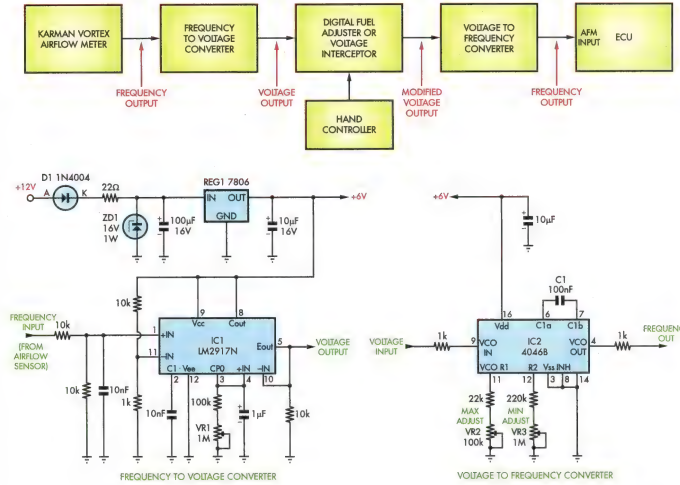
The Schmitt trigger's threshold input (pin 11) is set to about 0.55V by the 10kΩ and 1kΩ voltage divider connected across the 6V supply. The output from the Schmitt trigger drives a charge pump circuit involving the 10nF capacitor at pin 2 and the 1µF capacitor at pin 3. The charge pump voltage at pin 3 is applied to the non-inverting input of an internal op amp which functions as a unity gain buffer. Its output voltage is proportional to the input frequency.

Trimpot VR1 adjusts the output voltage range to suit the frequency range (note: more information on the LM2917 can be found in the Twin Engine Speed-Match Indicator article, SILICON CHIP, November 2009).

The voltage-to-frequency converter circuit uses the Voltage Controlled Oscillator (VCO) within a 4046 CMOS phase lock loop IC (IC2). Voltage is applied to the VCO's input at pin 9 and the output frequency is available at pin 4. The operating frequency is set by capacitor C1 and the resistances connected to the R1 and R2 inputs, pins 11 & 12.

When the VCO's input is at 0V, trimpot VR3 sets the minimum frequency. Conversely, when the VCO's input is at maximum voltage, VR2 sets the maximum frequency.

When setting up the frequency-to-voltage converter and voltage-to-frequency converters, the output from the frequency-to-voltage converter (IC1) is connected directly to the input of the voltage-to-frequency converter (IC2). Trimpot VR1 is then adjusted to give about 4V when the Karman Vortex airflow meter is producing its maximum frequency, ie, when the engine is running at maximum RPM and wide-open throttle (caution: the engine must be



loaded, as when driving up a hill).

Trimpot VR3 is then adjusted so that the frequency output from IC2 matches that of the Karman Vortex sensor at idle. Finally, VR2 is adjusted so that IC2's output frequency matches the Karman Vortex's maximum frequency.

In some cases, it may be possible to adjust the trimpots on the voltage-to-frequency converter so that the Karman Vortex frequency is modified sufficiently without having to use the Digital Fuel Adjuster or the Voltage Interceptor at all. You will be able to shift the idle frequency output by adjusting VR2 and the actual range of frequency output by adjusting VR1.

Note that when using the Digital Fuel Adjuster or the Voltage Interceptor with these converters, the minimum and maximum frequency output from the voltage-to-frequency converter is set by VR2 and VR3. If you want a wider frequency range, these trimpots will need to be adjusted accordingly. The Digital Fuel Adjuster or the Voltage Interceptor can then be used to alter the frequency output within the minimum and maximum frequency extremes.

John Clarke,
Silicon Chip.

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Dual Tracking ±0-19V Power Supply

By NICHOLAS VINEN

This linear bench supply can deliver up to 1.6A from positive and negative outputs with a range of ±0-19V. It has adjustable current limiting for both outputs and can display the voltage or current reading for either rail. If powered from an AC plugpack, no mains wiring is required, although less current is available. It also has a 5V 750mA output for powering digital logic ICs and microcontrollers.

THIS TRACKING bench supply is built almost entirely from standard components but provides high performance. It is a linear supply which offers very good regulation and very low ripple and noise (see specifications table). It also boasts a digital display for voltage and current readouts and this can also show the voltage across both rails or the present current-limit setting.

The primary outputs track each other, providing balanced rails, or a load can be connected across both to double the voltage. Either way, the current limit can be adjusted from 0-1.6A (0-1.0A for the plugpack version). The internal regulators are protected against excessive temperature or current.

A third output supplies a fixed 5.0V at up to 750mA. The supply also incorporates an earth terminal, a load switch (which controls all three outputs) and a power switch.

This supply is particularly well suited for breadboarding, especially

for circuits which mix digital logic and analog signal processing. If you prototype this type of circuit often you will be familiar with the hassles involved with building a power supply each time which is able to deliver 5V and/or 3.3V, along with balanced rails (eg, ±15V) for the op amps.

With a tracking supply such as this one, not only is most of that effort spared but you can easily observe the current consumed by the op amps and set the current limit to a suitable level so that a wiring mistake in the prototype will not cause any damage.

We have tried to keep the cost and complexity down as much as possible while providing several improvements over our original Dual Tracking Supply which we featured way back in the January 1988 issue. The improvements include current readout, adjustable current limit, fixed 5V output, digital display, a voltage measurement across both outputs, a larger transformer and the plugpack supply option.

Construction is simplified by mounting most of the front panel components on a second PC board. This is connected to the main PC board via several ribbon cables and a few heavy duty wires.

While all of the parts can be obtained from virtually any large electronics retailer, the 0.1Ω 5W shunt resistors can be replaced with less common 1% types (or better) for improved current measurement accuracy. Alternatively, use a millivoltmeter to test a number of 5% resistors for accuracy. We chose two at random for our first prototype and as luck would have it, they were within 1%.

Features

Because this is a tracking supply, under normal conditions, the absolute voltage at the negative output matches that of the positive output. In other words, if the positive output is adjusted to +9.3V, the negative output will be -9.3V. As a result, only one voltage adjustment knob is required. Many circuits, especially those with op amps, work best with balanced rails.

The 5.0V output is supplied by a 7805T regulator, which has its own current and thermal limiting. This rail also powers the panel meter and power LED, so if you manage to short the output, it will be obvious! It's best to avoid shorting it if possible but if the display goes blank, disconnect the 5.0V output (or clear the short) to restore it.

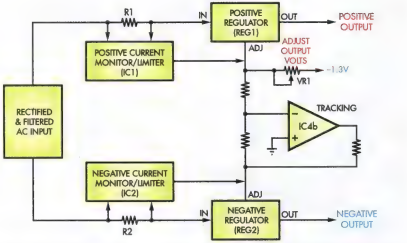


Fig.1: this block diagram shows the basic operation of the supply. Variable regulators REG1 & REG2 provide the positive and negative output rails, while IC4b ensures that REG2 tracks REG1. R1, R2, IC1 & IC2 monitor the rail currents and provide limiting as necessary.

The main current limit is controlled via a second knob on the front panel. You can view the current limit setting on the display while setting it accurately – there is no need to connect a load to make the adjustment.

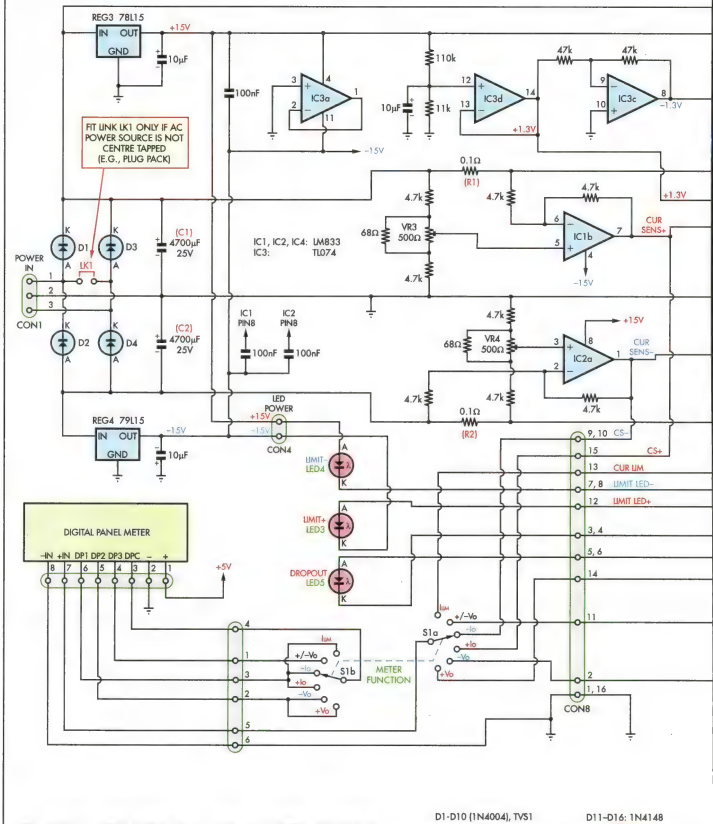
The current limit is applied for both primary outputs with a typical accuracy of ±3mA plus the measurement error. If the current from either primary output reaches the limit setting, that output voltage will drop as far as necessary to avoid exceeding the limit. This means you can also use the supply as a current source (from the positive rail) or sink (from the negative rail) by setting the voltage at maximum and the current limit as appropriate.

Our current limiting scheme is not a "foldback" design. With a foldback scheme, once the current limit is exceeded the output voltage drops virtually to zero until the overload is cleared. This provides better protection in the case of a dead short and limits power dissipation within the supply but foldback designs can not be used as a current source or sink and they can be unstable with reactive loads.

Because the two rails track, if the positive output is being current limited then the negative output voltage will also drop. However, the reverse is not true. If the negative output current limit is exceeded, the positive output voltage will not necessarily change. It has been designed this way to keep

Table 1: Specifications

	Internal Mains Transformer	External AC Plugpack
Output Voltage	±0-19V or +0-38V	
Output Current	Up to 1.6A (see Fig.5)	Up to 0.9A (see Fig.6)
Load Regulation	0.1% (0-1A)	0.1% (0-500mA)
Line Regulation (230V ±10%)	0.2%	0.2%
Noise (0-1A)	<525μV peak-to-peak (see Fig.7)	
Ripple (0-1A)	<1mV RMS, <1.7mV peak-to-peak (see Fig.7)	
Display	+ Voltage, - Voltage, + Current, - Current, Total Voltage, Current Limit	
Voltage Reading Accuracy	Typically <1%	Typically <1%
Current Reading Accuracy	Typically <2.5% ±10mA	Typically <2.5% ±10mA



DUAL TRACKING ±19V POWER SUPPLY

D1–D10 (1N4004), TVS1

D11–D16: 1N4148

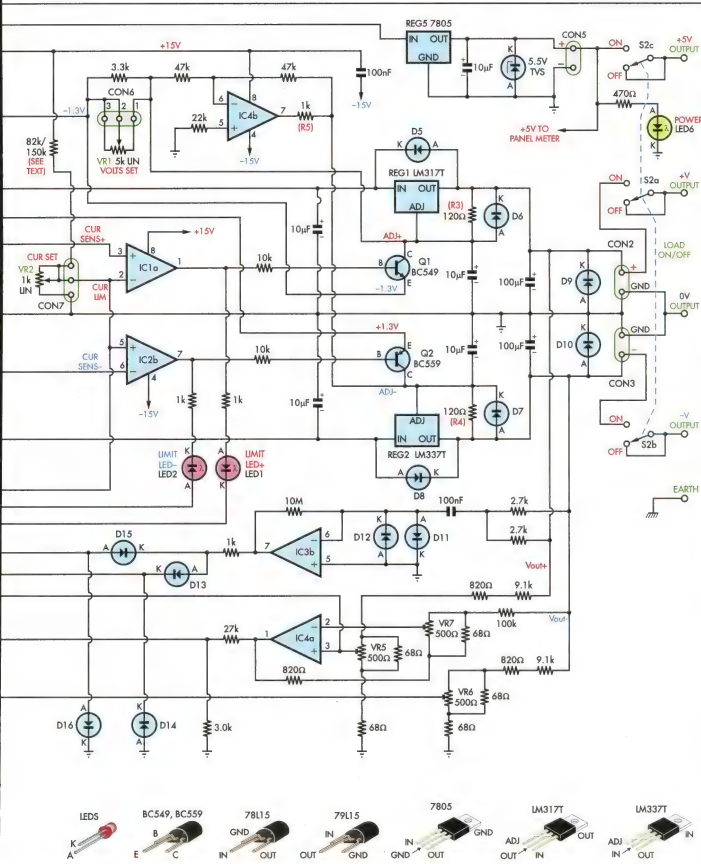
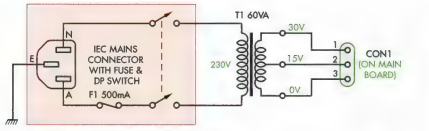
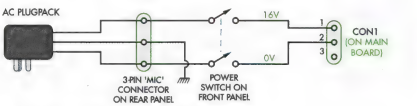


Fig.2: this diagram shows the complete circuit minus the mains transformer and the alternative plugpack supply. The parts shown with green labels mount on the front-panel PC board, while the remaining parts (except for the panel meter and power LED) are all mounted on the main board.



SC 02/2010 **DUAL TRACKING SUPPLY** MAINS SUPPLY OPTION

Fig.3: the mains-powered version uses an IEC connector with an integrated switch and fuse, plus a 60VA 30V centre-tapped mains transformer.



SC 02/2010 **DUAL TRACKING SUPPLY** PLUGPACK SUPPLY OPTION

Fig.4: this supply option uses a 16V 1.38A AC plugpack which connects via a 3-pin microphone connector on the rear panel of the unit.

cost and complexity low.

You can also use the current limiting feature when "bridging" the outputs to get the higher voltage range.

Note that if you are close to drawing the maximum current available at a given voltage setting, the current limit may kick in early. This is indicated by the current limit and dropout LEDs lighting simultaneously and will be due to the large 100Hz ripple voltage on the filter capacitors in this condition. Generally, it's best to avoid using the supply right at its limit, in which case this condition is avoided.

Supply options

A mains transformer or AC plugpack can be used to run the supply. The only difference is the amount of current that can be drawn from the outputs at a given voltage setting. Note that slightly less current is available if you use the LED display instead of the LCD option, due to its own current consumption. This will be more noticeable with the plugpack version.

The specified mains transformer is a 30V 60VA type with a centre tap. It has twice the VA rating of our earlier design, so more current can be delivered at voltages above 10V. The transformer is connected via an IEC socket with integrated switch and fuse, to keep the wiring as simple as possible.

If you prefer to avoid mains wiring, you can use a 16VAC 22VA plugpack instead. Virtually all plugpacks have a single secondary winding so we can't use full-wave rectification. This means that the filter capacitors are charged at 50Hz instead of 100Hz, reducing the output current further.

The specified plugpack has an earth wire so the front earth terminal works with either supply option. We don't recommend that you use a plugpack with a higher voltage rating as it could overload the current sense amplifier inputs.

We assume that most constructors will opt for the 60VA power transformer. However, we are also presenting the AC plugpack version so that the project can easily be built by school students as part of the electronics syllabus.

LED or LCD panel

We have chosen a digital display (LED or LCD) because such displays are much more precise and are cheaper than analog meters.

The display options are the Jaycar QP-5580 3.5-digit high-brightness LED panel meter and the Altronics Q0571 3.5-digit LCD panel meter. Both are "common ground" types, ie, their power supply does not have to float relative to the voltage being sensed.

The QP-5580 LED meter is larger and slightly more expensive than the Q0571 LCD meter; the LED meter is also very bright and easier to wire up. Ultimately, both work well so the choice is yours to make.

There are six readings we want to show (see Table 1) so there is a 6-way rotary switch which selects the desired mode. One switch pole connects the selected voltage to the display's input and the other selects the appropriate decimal place location.

Heatsink

The aluminium rear panel of the case is used as a heatsink for the three main regulators. They must be electrically insulated from it but because they can dissipate up to 30W each, the insulation must have a low thermal resistance and therefore mica washers are specified, not silicone types.

If you want to make the supply run cooler or deliver more current at low voltages, a finned heatsink can be drilled and attached to the rear panel using the regulator mounting bolts. Either the Altronics H0550 or Jaycar HH-8555 is suitable since they have 10mm fin spacing and the regulator tabs are spaced just under 30mm apart but note that you will need M3 x 20mm mounting screws.

Circuit description

While the above account of the new power supply's features may imply a very complex circuit, the basic circuit is not much different from that our of original January 1988 design. This is depicted in the block diagram of Fig.1. It essentially consists of positive and negative regulators which are forced to track together by op amp IC4b.

IC4b is effectively a negative voltage follower. It works so that the voltage setting called for from the positive regulator REG1, by potentiometer VR1, is fed to its inverting input. IC4b then inverts the signal and feeds it to the ADJ terminal of the negative regulator, REG2.

There is a lot of ancillary circuitry which provides all the current limit and metering options but IC4b and the two adjustable 3-terminal regulators are the heart of the circuit.

Turning now to the main circuit of Fig.2, it is rather large but each section is quite simple in its operation. Despite the large number of op amps, there are in fact only four DIP IC packages on the board, plus five 3-terminal

regulators (two in TO-92 packages) and two transistors. The remaining components are resistors, capacitors, diodes, LEDs and connectors.

Note that some of the components shown in Fig.2 are mounted on the front-panel PC board. These components are labelled with green text. The others are mounted on the main PC board. Several ribbon cables and heavy duty wires connect the two together, via connectors CON2-CON8.

The AC supply is shown separately in Figs.3 & 4 (depending on which version is being built). In either case, power from the mains transformer or AC plugpack is delivered to CON1, on the lefthand side of the circuit.

If a mains transformer is used, the AC waveform is full-wave rectified by diodes D1-D4. By contrast, for a plugpack, the secondary is connected between pins 1 & 2 and LK1 (on the main board) is installed. This connects the bridge diodes in parallel for half-wave rectification to give lower voltage losses.

The rectified voltage is filtered by capacitors C1 and C2, both 4700µF 25V (or higher), and the resulting DC rails are fed through shunts R1 and R2 to the main regulators REG1 and REG2 (over on the righthand side of the circuit). In addition, the 78L15/79L15 linear regulators REG3 and REG4 (left top and middle of the circuit) produce ±15V for the op amps.

The +15V rail is also used as a voltage reference for potentiometer VR2 and to generate the ±1.3V bias rails (more on these later).

Regulation

REG1 and REG2 are LM317T and LM337T adjustable regulators and are responsible for maintaining the correct output voltage and rejecting ripple from the AC supply. The 10µF capacitors across their inputs reduce the effect of the shunt resistance on the output voltage regulation.

The 10µF capacitors on the ADJ pins, in combination with the 100µF capacitors across the outputs, improve ripple rejection and reduce noise. Diodes D9 & D10 prevent voltages applied to the supply's outputs (eg, by an inductive load being switched off) from damaging any internal components.

REG1 and REG2 develop a nominal 1.25V between their OUT and ADJ terminals. With a 120Ω resistor (R3 & R4) connected between them, this means the quiescent current will be just over 10mA, which satisfies the minimum load requirement of the regulators.

REG1's output voltage is controlled by a potentiometer (VR1) connected between ADJ and -1.3V. This acts as a voltage divider in combination with R3.

If VR1 is set to, say, 1kΩ and the voltage across R3 is 1.25V then the voltage across VR1 will be 10.42V. In

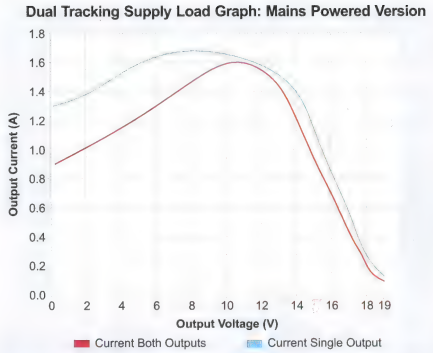


Fig.5: the load graph for the mains-powered version. It shows the maximum current available at any voltage setting before dropout for both dual outputs and a single output.

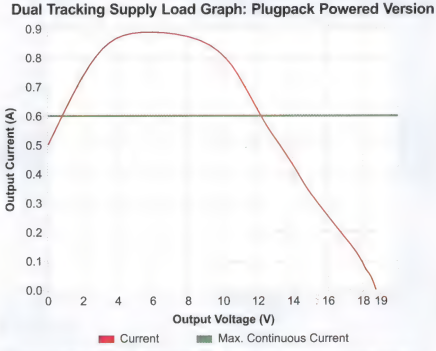


Fig.6: the load graph for the plugpack version. The curves are the same for both dual outputs and for a single output. Note that the total continuous current drawn from all outputs should not exceed 600mA.

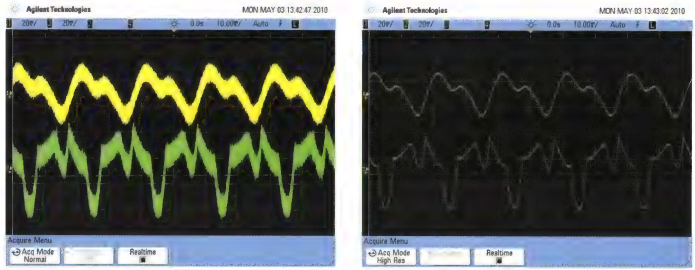


Fig.7: these scope grabs show the amplified noise and ripple at the outputs (yellow positive, green negative). The maximum ripple is 600µV RMS (1200µV p-p) at 1A for the positive rail and 940µV RMS (2200µV p-p) for the negative rail. The righthand scope grab shows the waveforms after averaging, which removes the noise component.

this case, the output voltage is 10.42V - 1.3V + 1.25V = 10.37V.

VR1 is mounted on the front-panel board and is connected to the main board via CON6. It has a 3.3kΩ resistor in parallel which sets the maximum output to 19.5V.

The -1.3V bias is important since it allows the output to be adjusted down to 0V. Without this, the ADJ pin could only go to 0V and so the output would not go below 1.25V. The -1.3V bias is slightly more than is necessary to account for regulator and resistor variations.

This -1.3V rail is generated by op amp IC3c, connected as an inverting amplifier. Its input is +1.3V which is generated by IC3d. IC3d is a voltage follower with its input tied to a voltage divider (110kΩ/11kΩ) between +15V and 0V.

Tracking

As noted earlier, op amp IC4b is responsible for the negative output voltage tracking the positive output (see the block diagram of Fig.1). Because we know the voltage across R3 and R4 is maintained at 1.25V, if the ADJ terminal voltages track, then so will the output voltages.

IC4b's output supplies current to REG2's ADJ terminal via 1kΩ resistor R5. Since there is 1.25V across R4, the current through R5 must be about 10mA. This means there is always 10V across R5.

Because IC4b's output can swing over a range of at least ±12V, REG2's ADJ pin can be controlled over a range of +2V to -22V, allowing tracking across the full range of output voltages.

Current sensing

The current flowing to the positive and negative outputs passes through resistors R1 and R2 (0.1Ω). The voltage drop across them is sensed by op amps IC1b and IC2a (each half an LM833).

IC1b and IC2a are configured as differential amplifiers with a gain of one. The output is ground-referenced and directly proportional to the drop across the sense resistor. For example, if there is a 50mV drop across R1, the output of IC1b will be close to 50mV and similarly for R2 and IC2a. IC2a's inputs are swapped relative to IC1b because current through R2 goes in the opposite direction.

Consider the voltage at pin 5 of op amp IC1b, the non-inverting input. Assuming precisely equal resistors and that VR3 is centred, it is exactly half the voltage across C1. If no current flows through R1 then pin 6 of IC1b, the inverting input, is at the same potential. Since the difference between the inputs of IC1b is 0V, its output should be at 0V.

As current begins to flow through R1, the voltage at pin 6 of IC1b decreases due to the voltage drop across R1. However, the voltage at pin 5 remains the same so the output of IC1b must rise to bring pin 6 up to the same voltage as pin 5. If the drop across R1 is 0.1V then IC1b's output must rise by 0.1V for the two inputs to remain at the same voltage.

Because a differential amplifier requires very accurately matched voltage dividers to operate correctly, we can't rely on the 1% tolerance resistors; they're not good enough. Trimpot VR3 allows the dividers at the inputs of IC1b to be adjusted so that their ratios match. VR4 does the same job for IC2a.

Ideally, we would use 50Ω or 100Ω trimpots (1-2% of 4.7kΩ). A higher value makes accurate adjustment too tricky. Since trimpots below 500Ω are hard to get, we have shunted 500Ω trimpots with 68Ω resistors. The resulting adjustment range is similar.

Because the inputs of the LM833s sit at half of the pre-regulated supply voltage and their guaranteed input voltage range is ±12V (typically ±14V), the maximum voltage across C1 and C2 should not exceed 24V. We have tested the mains-powered version and ensured that it does not exceed 24V with the maximum permissible supply voltage in Australia (230V+10% or 253V as per AS60038-2000).

For the plugpack version, if the mains voltage is well above 230V, the filtered voltage can be as high as 25.5V. In this case, the LM833's input voltage is still within typical specification. In the highly unlikely event that this affects the current limiting, that IC will need to be replaced with another sample.

Current sense errors

The combination of 0.1Ω shunt resistors and a differential gain of one means that the current sense outputs have a scale of 100mV/A. This is perfect since the panel meters we are

using have a 200mV full scale. We can display currents up to 1.999A with 1mA resolution by enabling the decimal place after the first digit.

However, the reading precision is not as good as this resolution. While we have found that it is possible to trim the output to within 1mA of the correct value, there are four sources of error: (1) The tolerance of R1 and R2. Common 0.1Ω resistors are only guaranteed to be within 5%. In practice, they are generally much closer than that but better results can be obtained with 1% resistors rated at 0.5W and above (eg, Farnell 1653230).
(2) The measurement includes about 10mA that is consumed by the regulator circuits. This is unavoidable since if we place the shunts after the regulators, we will seriously prejudice the load regulation of the supply. This error can be trimmed out with VR3 & VR4 but doing so inevitably degrades common mode rejection and possibly increases the scale error.
(3) IC1 and IC2 have an input offset voltage error, which results in a similar error at the output. We have chosen the LM833 for IC1, IC2 & IC4 because it is a common chip with a low input offset voltage, typically below 0.3mV. This represents an error of up to 3mA which can be trimmed out at the same time as the regulator current error.
(4) Due to the extreme resistor matching requirements, temperature drift is an issue. Since the divider resistors do not heat up and cool down at exactly the same rate, the divider ratio drifts. We have found that reducing the divider resistor values reduces temperature drift so have settled on 4.7kΩ.

Once the supply is trimmed and after it has warmed up, the error is typically no more than ±3mA plus 1% of the reading. The error when cold is more like 15mA, so for accurate readings, let the supply warm up first.

Current limiting

VR2, the 1kΩ current limit adjustment potentiometer, connects to the main board via CON7. It acts as a voltage divider with either an 82kΩ resistor (mains version) or 150kΩ resistor (plugpack version) to generate a voltage in the range of 0-170mV (or 0-100mV). This represents a current limit of 0-1.7A (or 0-900mA for the plugpack powered version).

This voltage, along with the current sense voltages, is fed to op amps IC1a & IC2b. Let us consider IC1a when the current sense voltage is below the preset limit. In this case, IC1a's pin 1 output will be low (about -13V), keeping NPN transistor Q1 and LED1 turned off.

If the current sense voltage exceeds the preset limit, IC1a's output swings positive, turning on Q1 and LED1 (along with the corresponding front-panel LED, LED3). Hence, Q1 pulls REG1's ADJ pin low, reducing REG1's output voltage. A steady state is reached in which the output current flow is just below the current limit and Q1 is held partially on.

Because the LED current partly depends on how much current is being sunk from the ADJ pin, the degree of overload is indicated by the brightness of the limit LEDs (LED3 & LED4).

If the load current is reduced, Q1 turns off and REG1's output voltage returns to normal. Q1's emitter is connected to -1.3V, for the same reasons as previously mentioned with respect to VR1. The output voltage needs to be brought down nearly to 0V in cases of severe overload (eg, short circuits).

While LED1 may be helpful during testing, its real purpose is to add an approximate 2V drop between the output of IC1a and LED3. This is necessary because LED3's cathode is connected to -15V but IC1a's output can only swing to -13V. Without this additional drop, LED3 would not turn off properly. A 1kΩ resistor provides current limiting for both.

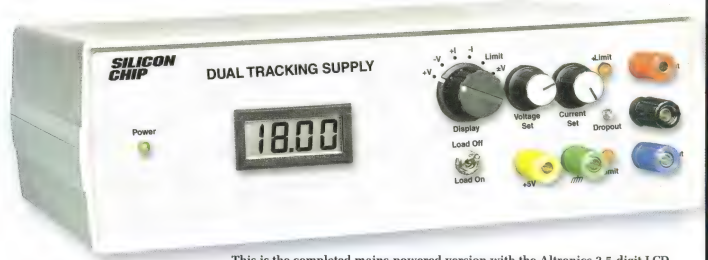
Current limiting for the negative output operates identically but is controlled by IC2b which drives Q2. When Q2 is turned on, so are LED2 and LED4. Q2's polarity and voltages are reversed compared to Q1 and the LEDs are connected in the opposite manner.

With the plugpack-powered version, it is a good idea to keep the current limit setting below 500mA. Otherwise, if a dead short is placed across the outputs, the ±15V rails can drop and the output current will only be limited by REG1 & REG2's internal circuitry.

LED dropout indicator

If high currents are drawn from the regulated outputs, the ripple voltage across the main filter capacitors, C1 & C2, will increase to a high level and as result, the outputs may no longer be properly regulated and there will be hum superimposed on the DC voltage.

This internal view shows the completed plugpack-powered version of the supply. It can be built into a smaller case than the mains-powered version.



This is the completed mains-powered version with the Altronics 3.5-digit LCD readout. The Jaycar LED readout can also be used – details next month.

This is clearly undesirable, so a dropout LED is mounted on the front panel. It lights if there is any significant AC component on either output. Two 2.7kΩ resistors mix the output voltages and the DC component is removed by a series 100nF capacitor. This signal is clipped to a maximum of 0.7V peak-to-peak by D11 & D12 and is then amplified by IC3b.

The gain is around 575 (taking into account the impedance of the 100nF capacitor) and the resulting signal is then rectified by D13-D16 and applied to the dropout LED (LED5) on the front panel. This LED is a red, high-brightness type and lights dimly with just a few millivolts of ripple on either output, growing progressively brighter with increasing ripple. It is quite bright by the time the ripple waveform reaches 100mV peak-to-peak.

5V fixed output

REG5 provides a fixed 5V output at up to 1A to power the 3.5-digit LED or LCD panel meter. Since the panel meter doesn't need anywhere near 1A, it is also fed to a binding post on the front panel so it can be used as a low-current auxiliary output.

Transient voltage suppressor TVS1 protects the circuit in case the 5V output is shorted to either the main positive or negative outputs. If it is shorted to a positive voltage in excess of 5V, the 5V rail voltage will rise and TVS1 clamps the 5V rail to around 7-8V to protect the panel meter (Note: a 6.8V 5W zener diode can be used instead of TVS1 – see next month).

If the positive rail current limit is set at its maximum, TVS1 could be conducting around 1.5A and dissipating 10W or more. TVS1 is only rated to dissipate that much power for about two seconds and if the short is maintained, TVS1 will ultimately fail.

This means that if such a short occurs, then the load or power should be switched off immediately.

By contrast, if the 5V output is shorted to the negative output, TVS1 is forward-biased and prevents the 5V rail from dropping below about -1V. Dissipation in this case is far less but it's still a good idea to disconnect the outputs as soon as possible.

The only remaining circuitry on the main board consists of the three voltage divider networks for driving the display. Since the panel meter is 200mV full-scale (ie, 199.9mV is displayed as 1999), we must divide the output voltages down by a factor of 100. A voltage of, say, 10V becomes 100mV which is displayed as "10.00".

The upper portion of these voltage dividers consists of 9.1kΩ and 820Ω resistors in series, for a total resistance of 9920Ω. The lower portion consists of two 68Ω resistors, one of which is in parallel with a 500Ω trimpot (VR5). By adjusting the trimpot, we can get very close to having an exact 100:1 ratio.

Resistor temperature drift is the most significant issue for making accurate readings and keeping the total resistance to 10kΩ or below helps significantly.

The third reading to be generated is the voltage across both rails, which is monitored by IC4a, another differential amplifier. The positive rail 100:1 divider for the panel meter is re-used, but the negative divider is not since it needs separate trimming. Once again, we are using a 500Ω trimpot (VR7) in parallel with a 68Ω resistor to compensate for any errors.

Because this reading can go above 20V, it must be further divided by 10 to stay within the 200mV range of the panel meter. A 10:1 divider on the output of IC4a (27kΩ and 3kΩ) gives the correct voltage level.

Front panel board

To simplify construction, the following components are mounted on the secondary PC board: the 6-way meter function switch S1, voltage and current adjustment potentiometers VR1 & VR2, LEDs3, 4 & 5, load switch S2 and the five binding posts – positive output, 0V, negative output, 5V output and earth.

As can be seen from the circuit of Fig.2, the load switch can disconnect all three outputs from the regulators.

The six readout signals are delivered to the front panel from the main PC board via a 16-way ribbon cable. Switch S1a connects the selected signal to the panel meter. At the same time, the other half of switch S1 (S1b) selects the appropriate decimal place for that reading.

A 6-pin connector joins the front panel to the panel meter. It carries the voltage reading to be displayed and its ground reference, plus the wires to select each decimal place. At any one time, one of the three decimal place wires is connected to the common wire and the other two are disconnected. The 5V power for the panel meter comes directly from the main board.

The two primary regulated outputs

Parts List

1 PC board, code 04206101, 113 x 105mm (main board)
1 PC board, code 04206102, 98 x 58mm (front panel board)
1 PC board, code 04206103, 63 x 28mm – required only if LCD panel meter used
2 2-way small screw terminal blocks (5.08mm pitch)
1 3-way small screw terminal block (5.08mm pitch)
1 8-way polarised header connector (2.54mm pitch)
2 3-way polarised headers (2.54mm pitch)
2 3-way polarised header connectors (2.54mm pitch)
2 2-way polarised headers (2.54mm pitch)
2 2-way polarised header connectors (2.54mm pitch)
1 16-way IDC vertical connector (2.54mm pitch)
1 16-way IDC line socket
3 TO-220 mica insulating pads with bushes
4 9mm tapped Nylon spacers
3 M3 x 10mm pan head machine screws
8 M3 x 6mm pan head machine screws
3 M3 nuts
1 3PDT miniature toggle switch
1 6-way 2-pole rotary switch
2 black push-on knobs to suit pots
1 black 24mm knob to suit
5 binding posts (red, black, white, green, yellow)
1 1m-length 0.71mm tinned copper wire
1 500mm length 16-wire rainbow ribbon cable
Heavy duty hookup wire (1m red, 500mm green/yellow, 500mm black)
1 50mm length heatshrink tubing (3mm diameter)
1 3.5-digit LED panel meter (common ground) (Jaycar QP-5580) *or* 3.5-digit LCD panel meter (common ground) (Altronics Q0571)
15 small cable ties
1 small quantity of thermal grease
1 8-way 90° polarised header (2.54mm pitch) – required only if LCD panel meter used
1 5kΩ 16mm linear potentiometer (code 502) (VR1)
1 1kΩ 16mm linear potentiometer (code 102) (VR2)
5 500Ω horizontal trimpots (code 501) (VR3-VR7)

Pluggpack version only

1 plastic instrument case, 200 x 158 x 64mm (Jaycar HB-5912, Altronics H0480F)
1 16VAC 1.38A AC plugpack with earth lead (Altronics M9332A)
1 DPDT miniature toggle switch
1 3-pin male chassis mount microphone socket (Altronics P0954)
1 3-pin female line microphone connector (Altronics P0949)
1 aluminium sheet, 190 x 60mm, or Altronics H0486 for rear panel
1 aluminium sheet, 170 x 127mm
1 5.3mm eyelet crimp lug
1 M4 x 15mm pan head machine screw
1 M4 star washer
1 M4 nut
4 No.4 x 6mm self-tapping screws

Mains powered version only

1 plastic instrument case, 260 x 190 x 80mm (Jaycar HB-5910, Altronics H0482)
1 60VA 30V centre-tapped mains transformer (Jaycar MM2005, Altronics M6674L)
1 chassis-mount IEC socket with fuse and power switch (Jaycar PP4003, Altronics P8341)
2 500mA M205 fast-blow fuses (1 spare)
1 aluminium sheet, 248 x 76mm for rear panel
1 aluminium sheet, 224 x 155mm
7 4.8mm insulated spade crimp lugs
7 5.3mm eyelet crimp lugs
7 M4 x 15mm pan head machine screws
4 M4 spring washers
6 M4 star washers
10 M4 nuts
6 No.4 x 6mm self-tapping screws
1 200m length 5mm diameter heatshrink tubing

Semiconductors

3 LM833 dual op amps (IC1, IC2, IC4)
1 TL074 quad op amp (IC3)
1 LM317T adjustable regulator (REG1)
1 LM337T adjustable regulator (REG2)
1 78L15 linear regulator (REG3)
1 79L15 linear regulator (REG4)
1 7805 linear regulator (REG5)
1 BC549 small signal transistor (Q1)
1 BC559 small signal transistor (Q2)
10 1N4004 diodes (D1-D10)
6 1N4148 diodes (D11-D16)
1 P4KE6.8 5.5V transient voltage suppressor (TVS1) or 6.8V 5W zener diode
2 5mm red LEDs (LED1, LED2)
2 5mm amber or orange LEDs (LED3, LED5)
1 5mm high-brightness red LED (LED4)
1 5mm green LED (LED6)

Capacitors

2 4700µF 25V or 35V electrolytic
2 100µF 25V electrolytic
8 10µF 25V electrolytic
5 100nF MKT polyester

Resistors

1 10MΩ	8 4.7kΩ
1 110kΩ	1 3.3kΩ
1 100kΩ	1 3kΩ
4 47kΩ	2 2.7kΩ
1 27kΩ	4 1kΩ
1 22kΩ	3 820Ω
1 11kΩ	1 470Ω
2 10kΩ	2 120Ω
2 9.1kΩ	7 68Ω

2 0.1Ω 5W 5% or 0.1Ω 1W 1% (Farnell 1653230)
1 150kΩ (mains version) or 82kΩ (plugpack version)

and their ground returns, as well as earth, are connected to the front panel via heavy duty wire. Because the front panel carries the load switch and output terminals, no extra wiring is necessary. However, the main power switch, power LED and panel meter are mounted separately.

That's it for this month. Next month we will describe how to build the PC boards, install them in the case and wire it all up. SC

Digital Insulation Meter

By JIM ROWE

Think all your double-insulated power tools are safe, just because they are double insulated? As many have found to their ultimate cost, wear and tear on tools can mean that they become decidedly unsafe. Here's a meter that will give you back your peace-of-mind – on tools and many other electrical and electronic devices.

This is actually an improved version of the Digital Megohm & Leakage Current Meter we described in the October 2009 issue of SILICON CHIP.

Our original design had a distinctly mixed reception from some of our readers. It could be summed up as "OK but ...."

The first "but" was that it would not deliver the nominal test voltage of 1000V or 500V DC into the minimum load resistance of one megohm, as specified in the relevant Australian Standard, ie, AS/NZS 3760:2003.

The reason for this drawback was largely because we had set the internal current limit too low and partly because the DC-DC converter could not deliver the current required, even if the current limiting resistor had been removed.

Furthermore, some readers pointed out that the test voltage of 500V DC was too high for testing insulation of equipment with EMI suppression and MOVs (metal oxide varistors). These devices should be tested at no more than 250V DC.

Faced with that criticism, all we could do was to revise the design so that (a) the inbuilt DC-DC converter can deliver the full test voltage into a 1MΩ resistor and (b) provide the additional test voltage of 250V DC. In fact, the new circuit can deliver the test voltage of 250V or 500V into a load of 100kΩ, if required, for the testing of portable RCDs (residual current devices).

The physical presentation of the new meter is also quite similar to the original except that it now has a 3-position switch to select the test voltages of 250V, 500V or 1000V DC.

Apart from the redesigned inverter section, the revised meter now has two current ranges instead of one, under the control of a PIC microcontroller.

As before, the Digital Insulation Meter is easy to build, with most of the major components mounted directly on two small PC boards. These fit snugly inside a compact UB1 size jiffy box, along with a 6xAA battery holder used to supply the meter's power.

It can be built up in a few hours and for an outlay much lower than commercially available electronic megohm meters.

So to summarise, it can now test at 250V, 500V or 1000V and can measure leakage currents from below 1μA to above 6mA. As well, it can measure insulation resistance from below 1MΩ up to 999MΩ.

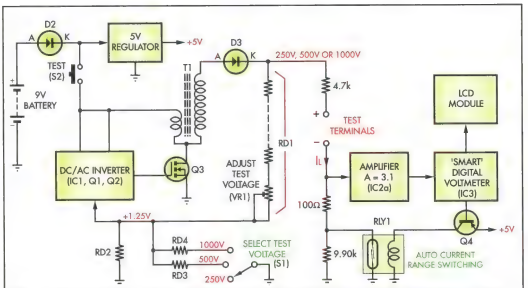


Fig.1: in this block diagram, the two sections of the circuit can be clearly identified. On the left is the power supply, consisting of a regulated 5V plus a high-voltage supply. On the right is the metering and display unit. These can be seen in the two separate PC boards below.

How it works

The block diagram of Fig.1 shows the arrangement of the new meter with its somewhat more complex DC-DC converter. This is on the left-hand side.

The metering section, on the right side of the diagram, is used to measure any leakage current which flows between the test terminals and from this it calculates the external resistance connected between them (knowing the test voltage in use).

In more detail, the DC-DC converter converts the 9V DC from the battery into AC, so it can be stepped up to a few hundred volts using an auto-transformer. The resulting high voltage AC is then rectified using ultra-fast diode D3 to produce the test voltage of 250V, 500V or 1000V DC.

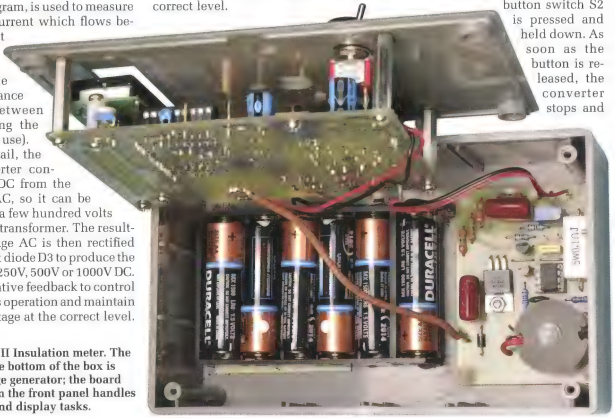
We use negative feedback to control the converter's operation and maintain its output voltage at the correct level.

The feedback uses a voltage divider (RD1 and RD2) to feed a small proportion of the high voltage DC output back to one input of a comparator inside IC1, where it is compared with an internal 1.25V reference voltage.

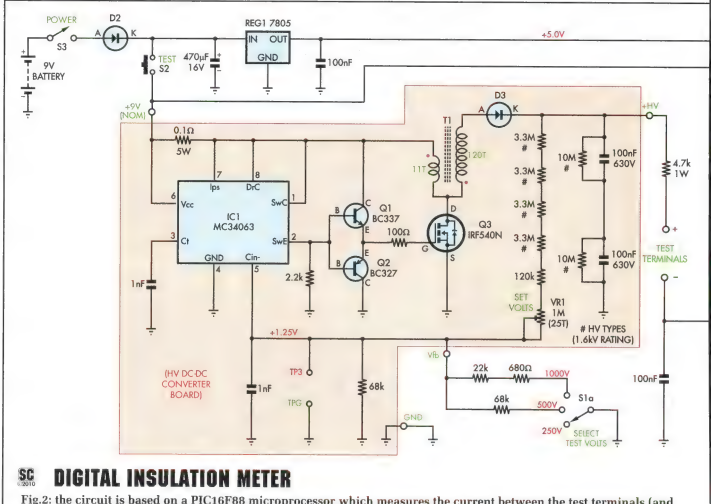
The output of the comparator is then used to control the operation of the DC-DC converter, turning it on when the output voltage is below the correct level and turning it off again when the output voltage reaches the correct level.

The basic voltage divider using RD1 and RD2 alone is used to set the high voltage level to 250V, with multi-turn trimpot VR1. To change the test voltage level to 500V or 1000V, switch S1 is used to connect RD3 or RD4 in parallel with RD2, increasing the division ratio of the divider and hence increasing the output voltage maintained by the feedback loop.

Note that the converter generates the test voltage only when TEST button switch S2 is pressed and held down. As soon as the button is released, the converter stops and



Inside our Mk II Insulation meter. The PC board in the bottom of the box is the high voltage generator; the board "hanging" from the front panel handles the metering and display tasks.



DIGITAL INSULATION METER

Fig.2: the circuit is based on a PIC16F88 microprocessor which measures the current between the test terminals (and therefore the device under test). The high voltage DC-DC converter supplies up to 1000V for these tests in accordance with the relevant Australian/New Zealand standards. It can also supply lower voltages (250 and 500V) as required.

the high voltage leaks away via RD1 and RD2/RD3/RD4. This is both a safety feature and a simple way to achieve maximum battery life.

Referring back to Fig.1, the meter section uses a shunt resistor connected between the negative test terminal and ground to sense any leakage current I_L which may flow between the test terminals. It is the voltage across this resistor which we measure, to determine the leakage current. The effective shunt resistance is switched between 100Ω and 10kΩ to give the meter two measurement ranges. The switching is done using relay RLY1, under the control of the PIC microcontroller (IC3) inside the metering circuit.

Initially the shunt has a value of 100Ω, which means that a leakage current of 10mA produces a voltage drop of 1.00V. This provides the 'high current' measuring range. If and when the measured leakage current falls below 100µA, RLY1 is turned off to increase the effective shunt resistance to 10kΩ. This provides the 'low current' measuring range, where a leakage current of 100µA produces a voltage drop of 1.00V.

If this shunt resistance relay switching looks familiar, that's because we used a similar arrangement in the Capacitor Leakage Meter published in the December 2009 issue and in the Capacitor Leakage Adaptor for DMMs in the April 2010 issue.

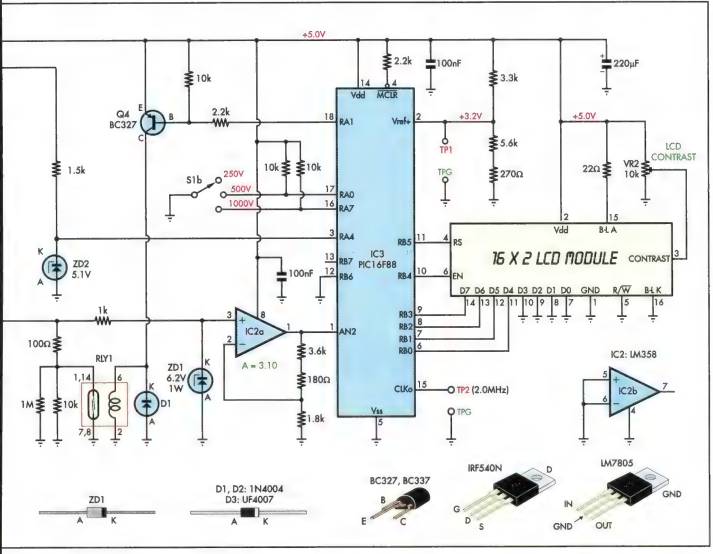
The voltage drop across the shunt resistance is fed through op amp IC2a which has a voltage gain of 3.1 times. IC2a drives IC3, a PIC16F88 microcontroller which is used as a 'smart' digital voltmeter.

The amplified voltage from IC2a is fed to one input of the ADC (analog to digital converter) module inside IC3, where it is compared with a reference voltage of 3.2V. The digital output of the ADC is then mathematically scaled, to calculate the level of the leakage current in milliamps or microamps.

IC3 is then able to use this calculated current level to work out the insulation resistance, because it can sense the position of switch S1 and hence 'knows' whether the test voltage being used is 250V, 500V or 1000V.

So all it has to do is calculate the total resistance which will draw that level of leakage current from the known test voltage, and then subtract the 'internal' 4.7kΩ and 100Ω/10kΩ resistors from this total value to find the external resistance between the test terminals. The calculated leakage current and insulation resistance values are then displayed on the LCD, along with the test voltage being used.

In case you're wondering about the purpose of the 4.7kΩ resistor connected between the high voltage generation circuit and the positive test terminal (ie, inside the meter), it's mainly to limit the maximum current that can be drawn from the DC-DC converter – even in the event of a short circuit between the test terminals.



This should make the meter relatively safe to use, especially as it won't be too easy to connect yourself between the two test terminals while simultaneously holding down the Test button.

Of course, if you're really determined to give yourself a shock it can be done . . . but we wouldn't recommend it!

Incidentally, if you do deliberately short circuit the output terminals while pressing the test switch (S2), you will burn out the 4.7kΩ 1W current-limiting resistor; it can be regarded as a fusible resistor. You will then have to replace the resistor but at least the rest of the circuit will have been protected.

If you suspect that you have blown the 4.7kΩ resistor by shorting the output, test the output voltage of the unit with your DMM on a high DCV range. If there is voltage, it's still working!

Circuit details

Now let's look at the full circuit diagram of Fig.2.

The DC-DC converter is based on IC1, an MC34063 converter/controller which drives MOSFET Q3 via driver transistors Q1 and Q2. When the inverter is operating, the transistors switch Q3 on for a brief time (about 50µs) which allows current to flow from the +9V supply through the primary winding of transformer T1.

As a result, energy is stored in T1's magnetic field. Then Q3 is switched off again, causing the magnetic field to collapse. This causes a high 'back-EMF' voltage to be generated in both windings of T1, which are connected in auto-transformer fashion, so that the total voltage applied to the anode of diode D3 is equal to the sum of the back-EMF in both windings plus the 9V supply voltage.

D3 then conducts to charge up the series-connected 100nF/630V capacitors to this high voltage. Both of these capacitors have a 1.6kV-rated 10MΩ shunt resistor included to ensure that the converter's high output voltage is shared equally between them. This is only important when the test voltage setting is 1000V – we want to ensure that neither capacitor has its 630V rating exceeded.

The four 3.3MΩ high-voltage resistors, together with the 120kΩ resistor and trimpot VR1, correspond to the upper divider resistor RD1 in Fig.1. The 68kΩ resistor connected between pin 5 of IC1 and ground corresponds to RD2, the fixed lower leg of the feedback divider which provides the converter's 250V output voltage. The other 68kΩ resistor switched by S1a corresponds to RD3, while the 22kΩ and 680Ω resistors connected in series correspond to RD4.

Providing S2 is on, the converter will continue to run until the high voltage output reaches the correct level. That's because until this level is reached, the proportion of the

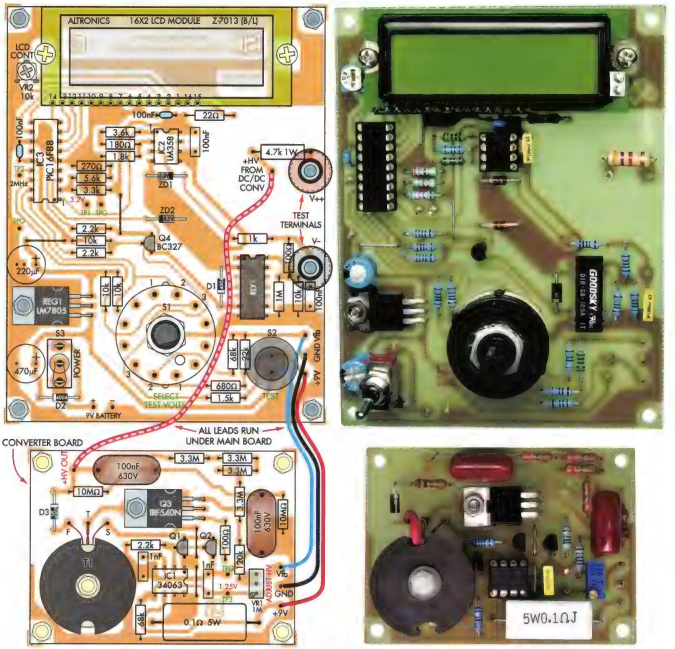


Fig.3: component layouts for both the main (measurement/display) PC board (top) and the high voltage DC-DC converter PC board (bottom), along with matching photographs alongside. Follow these diagrams exactly, not only to ensure your unit works perfectly but also to minimise the risk of you getting a bite. (It probably won't do any damage but why risk it!)

output voltage fed back to the comparator input (pin 5) of IC1 will not reach the +1.25V reference level inside IC1. However as soon as the high voltage output does reach the correct level, the proportion fed back to pin 5 will rise just above 1.25V and IC1 will stop turning Q3 on – stopping the converter even if S2 is still being held down.

The converter gets its power directly from power switch S3 (via S2 and D2), so it is supplied with the full battery voltage less the drop in D2. All of the remaining circuitry in the meter operates from a regulated +5V supply line, derived from the battery via REG1, an LM7805 3-terminal regulator.

Smart metering

The metering side of the circuit is fairly straightforward, thanks to the use of a PIC16F88 micro (IC3). As noted before, the signal from op amp IC2a is fed to pin 1 of IC3, which is configured as ADC input channel AN2 and the micro-controller then makes its calculations to drive the LCD.

Once it has measured and calculated the leakage current in this way, the micro can then calculate the effective leakage resistance. This is because it is able to sense the position of test voltage selector switch S1, via the contacts of S1b which are connected to input pins 17 (RA0) and 16 (RA7). So knowing the test voltage in use it can calculate the total resistance connected between the test terminals. Then finally it works out the external resistance between the terminals by subtracting the 4.8kΩ or 14.7kΩ internal resistance.

Both of the calculated current and resistance values are then displayed on the LCD module, along with the test

Winding the transformer

Step-up autotransformer T1 has a primary winding comprising 11 turns of 0.7mm enamelled copper wire (one layer), followed by a secondary winding of 120 turns (4 x 30-turn layers) of 0.25mm enamelled copper wire. As shown in the assembly diagram at right, all five layers are wound on a small Nylon bobbin which fits inside a two-piece ferrite pot core measuring 26mm in diameter.

First wind on the 11-turn primary using the 0.7mm diameter wire. You'll find that this will neatly take up the full width of the bobbin providing you wind the turns closely and evenly. Then cover this first layer with a 9mm-wide strip of plastic insulating tape or thin 'gaffer' tape, to hold it down.

Leave about 50mm of wire free of the bobbin at the 'start' end, and cut any surplus wire off about 40mm from the 'finish/tap' end (taking it out via one of the 'slots').

Next take one end of the 0.25mm wire and twist it around the 'finish/tap' end of the primary winding to anchor it while you wind the first layer of the secondary. This must be wound on the bobbin in the same direction as the primary, as if it is a continuation of the first layer. If you wind them closely and evenly you should find that you will be able to fit 30 turns across the bobbin.

Once you have wound on the 30 turns, cover this second layer (the first secondary layer) with a 9mm-wide strip of plastic insulating tape to hold it in place. Then you can wind the third layer in exactly the same way, covering it with a strip of tape as before.

The remaining wire can then be used to wind the two further 30-turn layers, again making sure that you wind them in the same direction as you wound the earlier layers and covering each layer with a strip of tape.

With fifth and final layer been wound and taped, the 'finish' end of the wire can then be brought out of the bobbin via one of the slots (on the same side as the start and tap leads), and your wound transformer bobbin should be ready to fit inside the two halves of the ferrite pot core.

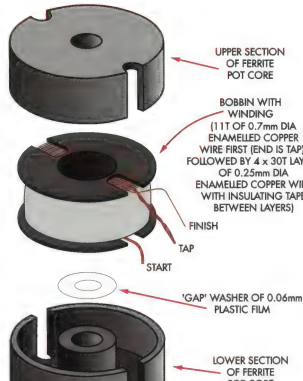
Just before you fit the bobbin inside the bottom half of the pot core, though, there's a small plastic washer to prepare. This is to provide a thin magnetic 'gap' in the pot core when it's assembled, to prevent the pot-core from saturating (magnetically) when it's operating.

The washer is very easy to cut from a piece of the thin clear plastic that's used for packaging electronic components, like resistors and capacitors. This plastic is very close to 0.06mm thick, which is just what we need here. So the idea is to punch a 3-4mm diameter hole in a piece of this plastic using a leather punch (or something similar to cut a clean hole) and then use a small pair of scissors to cut around the hole in a circle, with a diameter of 10mm.

Your 'gap' washer will then be ready to place inside the lower half of the pot core, over the centre hole.

Once the gap washer is in position, you can lower the wound bobbin into the pot core around it, and then fit the top half of the pot core. The autotransformer should now be ready for mounting on the converter PC board. To begin this step, place a Nylon flat washer on the 25mm-long M3 Nylon screw that will be used to hold it down on the board.

Then pass the screw up through the 3mm hole in the PC board corresponding to the centre of the transformer, and lower the assembled pot core down over the Nylon screw, holding it together with your fingers (with the bobbin and gap washer inside) and with the 'leads' towards diode D3.



(ASSEMBLY HELD TOGETHER & SECURED TO CONVERTER PC BOARD USING 25mm x M3 NYLON SCREW & NUT)

Then when the pot-core assembly is resting on the top of the converter board, keep holding it and the board together with the Nylon screw together so you can apply the second M3 Nylon flat washer and M3 nut to the upper end of the screw. Tighten the nut so that the pot core is not only held together but also secured to the top of the PC board.

Once this has been done, all that remains as far as the transformer is concerned is to cut the start, tap and finish leads to a suitable length, scrape the enamel off their ends so they can be tinned, and then pass the ends down through their matching holes in the board so they can be soldered to the appropriate pads.

Make especially sure that you scrape, tin and solder BOTH wires which form the 'tap' lead – ie, the finish of the primary winding and the start of the secondary. If this isn't done, the transformer won't produce any output.

It's also a good idea to fit a 25mm length of insulating sleeving over the exposed 'finish' lead, between the transformer winding and the PC board. This will help prevent any 'flashover' when the transformer is producing 1000V pulses.

PARTS LIST – DIGITAL INSULATION METER

1 UB1 size jiffy box, 157 x 95 x 53mm
1 PC board, code 04106101, 109 x 84mm
1 PC board, code 04106102, 70 x 51mm
1 LCD module, 2 lines x 16 characters with LED back-lighting (Altronics Z-7013, Jaycar QP-5512 or equivalent)
1 Ferrite pot core pair, 26mm OD, with bobbin to suit
1 500mm length of 0.7mm diameter enamelled copper wire
1 8m length of 0.25mm diameter enamelled copper wire
1 100mm length 0.7mm diameter tinned copper wire
1 10x AA battery holder (flat), cut down to 6x
1 2-pole rotary switch, PC board mounting, with 16mm knob (S1)
1 SPST pushbutton switch, panel mounting (S2)
1 SPDT mini toggle switch, panel mounting (S3)
1 Mini DIL reed relay, SPST with 5V coil
2 Binding post/banana jacks (1 red, 1 black)
2 4mm solder lugs
1 16-pin length of SIL socket strip
1 16-pin length of SIL pin strip
1 18-pin IC socket
2 8-pin IC sockets
4 25mm M3 tapped metal spacers
2 12mm M3 tapped Nylon spacers
11 6mm M3 machine screws, pan head
4 6mm M3 machine screws, csk head
3 M3 hex nuts, metal
4 12mm M3 machine screws, Nylon
1 25mm M3 machine screw, Nylon
9 M3 hex nuts, Nylon
6 M3 flat washers, Nylon
12 1mm diameter PC board terminal pins

Semiconductors

1 MC34063A converter controller (IC1)
1 LM358 dual op amp (IC2)
1 PIC16F88 microcontroller, programmed with 0410610A.hex (IC3)
1 LM7805 5V regulator (REG1)
1 BC337 NPN transistor (Q1)
2 BC327 PNP transistor (Q2,Q4)
1 IRF540N 100V N-channel Mosfet (Q3)
1 6.2V 1W zener diode (ZD1)
1 5.1V 1W zener diode (ZD2)
2 1N4004 1A diode (D1,D2)
1 UF4007 ultra-fast 1000V diode (D3)

Capacitors

1 470µF 16V RB electrolytic
1 220µF 10V RB electrolytic
2 100nF 630V metallised polyester
2 100nF 100V MKT metallised polyester
2 100nF multilayer monolithic ceramic
2 1nF 100V MKT metallised polyester

Resistors (0.5W 1% metal film unless specified)

2 10MΩ HV*		4 3.3MΩ HV*		** HV (1.6kV rated) eg MH25 series Farnell 110-0295 (10MΩ) and Farnell 110-0288 (3.3MΩ)*
1 1MΩ	1 120kΩ	2 68kΩ	1 22kΩ	
4 10kΩ	1 5.6kΩ	1 4.7kΩ1W	1 3.6kΩ	
1 3.3kΩ	3 2.2kΩ	1 1.8kΩ	1 1.5kΩ	
1 1kΩ	1 680Ω	1 270Ω	1 180Ω	
2 100Ω	1 22Ω	1 0.1Ω 5W wirewound		

1 1MΩ mini 25T vertical trimpot (VR1)
1 10kΩ mini horizontal trimpot (VR2)

voltage being used.

IC3 is using its internal clock oscillator, running at very close to 8MHz. This gives an instruction cycle time of 2MHz, which may be monitored using a scope or frequency counter at test point TP2.

Trimpot VR2 allows the LCD module's contrast to be adjusted for optimum visibility, while the 22Ω resistor connected to pin 15 sets the current level for the module's inbuilt LED back-lighting. This was chosen for the best compromise between display brightness and battery life, as the LED back-lighting is a major component of total battery current.

Construction

As you can see from the photos and diagrams, most of the components used in the new meter are mounted directly on two small PC boards.

The high voltage converter circuitry all mounts on the smaller of the two boards, which measures 70 x 51mm and is coded 04106102. This board sits in the bottom of the UB1 box, at the front of the 6xAA cell battery holder.

Most of the remaining components mount on the larger board, which measures 109 x 94mm and is coded 04106101. This board attaches to the underside of the box lid/front panel via four 25mm long M3 tapped spacers.

The only components not mounted on either board are the test terminals, pushbutton switch S2 and power switch S3; these all mount directly on the lid/front panel.

The location of all of the components mounted on both boards, along with their correct orientation, should be clear from the overlay diagram of Fig.3.

There are only two wire links to be fitted to each board, so these are best soldered first so they won't be forgotten. After both pairs of links are in place you can fit the terminal pins on the larger board, for test points TP1 and TP2 and their reference grounds plus those for the 9V battery connections (at lower left) and the three at lower right for the interconnections to the converter board.

There are a further six terminal pins to fit on the smaller board: for TP3 and its ground, the three interconnection wires to the larger board (at lower right) and finally for the high voltage output (upper left).

Once the terminal pins have been

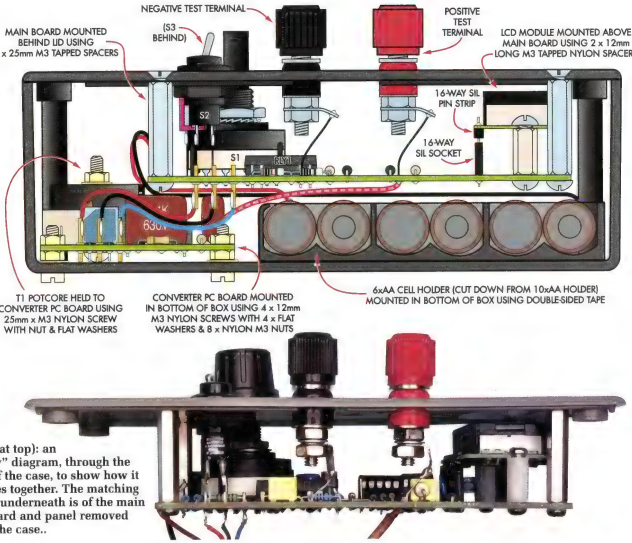


Fig.4 (at top): an "X-ray" diagram, through the side of the case, to show how it all goes together. The matching photo underneath is of the main PC board and panel removed from the case..

fitted you can fit the sockets for IC1 (on the smaller converter board), IC2 and IC3.

Next come all of the fixed resistors, taking particular care to fit each value in its correct position. Follow these with the two trimpots, making sure you fit these with the orientation shown in Fig.3.

The capacitors are next, starting with the lower value ceramic and metallised polyester caps and following these with the 1nF (on the converter board) and the two polarised electrolytics on the main board – again matching their orientation to that shown in Fig.3. The 100nF 630V polyester caps can be fitted also at this stage.

After the capacitors you can fit diodes D1 and D2 on the main board and D3 on the converter board, taking care to orientate them as shown in Fig.3 and also to fit the UF4007 diode as D3. These diodes can then be followed by zener diodes ZD1 and ZD2, which both go just above the centre of the main board. Note that these are orientated in opposite ways as shown in Fig.3, and also that the 6.2V zener is ZD1 while the 5.1V zener is ZD2.

Now you can solder transistors Q1 and Q2 to the converter board, making sure that you fit the BC337 device as Q1. You can also fit the remaining BC327 transistor (Q4) on to the main board.

After the transistors you can fit reed relay RLY1, making sure you orientate it with the 'notch' end uppermost as indicated in Fig.3. Then comes the rotary switch (S1), after first cutting its spindle to a length of about 15mm from the threaded mounting sleeve and filing off any burrs.

Mount the switch in the board so that it is orientated with the locating spigot in the '5 o'clock' position, and push the switch pins through the board holes as far as they'll go before soldering to the pads underneath.

Once the switch is fitted, you should remove its main nut/lockwasher/position stopwasher combination and turn the spindle by hand to make sure it's at the fully anticlockwise limit. Then refit the position stopwasher, making sure that its stop pin goes down into the hole between the moulded '3' and '4' digits.

After this refit the lockwasher and nut to hold it down securely, allowing you to check that the switch is now 'programmed' for the correct three positions – simply by clicking it around through them by hand.

Next fit the LM7805 regulator (REG1) on the main board. This is in a TO-220 package and mounts flat against the top of the board, with its leads bent down by 90° about 6mm from the case so they pass down through the board holes. The regulator is then attached to the board using a 6mm long M3 screw and nut, passing through the hole in its tab. The screw and nut should be

tightened to secure the regulator in position before its leads are soldered to the pads underneath.

Mosfet Q3 is also in a TO-220 package and is mounted on the smaller converter board in exactly the same way.

The final component to be mounted directly on the main board is the 16-way length of SIL (single in-line) socket strip used for the 'socket' for the LCD module connections. Once this has been fitted and its pins soldered to the pads underneath, you'll be almost ready to mount the LCD module itself.

However, before this can be done fasten two 12mm long M3 tapped nylon spacers to the board in the module mounting positions (one at each end) using a 6mm M3 screw passing up through the board from underneath and then 'plug' a 16-way length of SIL pin strip into the socket strip you have just fitted to the board. Make sure the longer ends of the pin strip pins are mating with the socket, leaving the shorter ends uppermost to mate with the holes in the LCD module.

Next remove the LCD module from its protective bag, taking care to hold it between the two ends so you don't touch the board copper. Then lower it carefully onto the main board so the holes along its lower front edge mate with the pins of the pin strip, allowing the module to rest on the tops of the two 12mm long nylon spacers.

Then you can fit another 6mm M3 screw to each end of the module, passing through the slots in the module and mating with the spacers. When the screws are tightened (but not over tightened!) the module should be securely mounted in position.

The final step is then to use a fine-tipped soldering iron to carefully solder each of the 16 pins of the pin strip to the pads on the module, to complete its connections.

The final component to mount on the converter board is step-up transformer T1, which needs to be wound first. This may sound daunting, but there are only 131 turns of wire in all. You'll find all of the information on winding the transformer and mounting it on the converter board in the box panel.

After this is done you can plug the three ICs into their respective sockets - IC1 on the converter board and IC2 and IC3 on the main board – making sure to orientate them all as shown in Fig.3.

At this stage both of your PC board assemblies should be nearly complete. All that remains is to attach one of the 25mm long mounting spacers to the top of the main board in each corner, using 6mm long M3 screws. Then the board assemblies can be placed aside while you prepare the case and its lid.

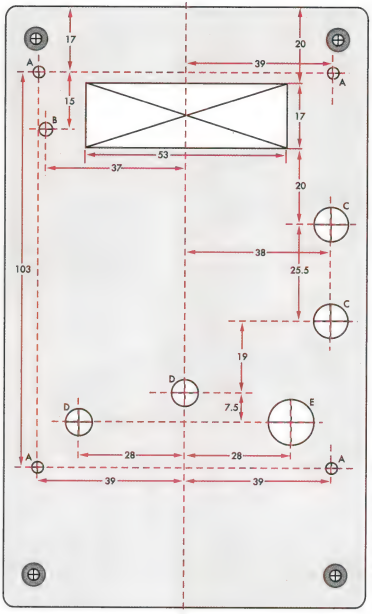


Fig.5: drilling diagram for the UB-1 box lid, which becomes the front panel. All dimensions are in mm.

Preparing the case

There are only four holes to be drilled in the lower part of the case, to take the mounting screws for the converter board. These should be 3mm in diameter and with their centres marked out using the converter board itself as a 'template', by sitting it temporarily inside the box spaced only about 1mm from the front.

Once these four holes are drilled and de-burred, you can mount the converter board inside the box using four 12mm long M3 Nylon screws, with a Nylon flat washer and Nylon nut fitted to each screw first to act as board mounting pillars or 'standoffs'. Then the board can be slipped down over the screws, and another M3 Nylon nut placed on each screw to hold the board in place.

You don't need mounting holes for the battery holder, because it can be held securely in place using two strips of 'industrial' double-sided adhesive foam tape. However before it can be fitted into the case it must be cut down to accommodate only six cells.

This involves cutting off the last four cell positions altogether (at the 'negative lead' end), and then drilling a 2.5mm hole in the end of the sixth cell

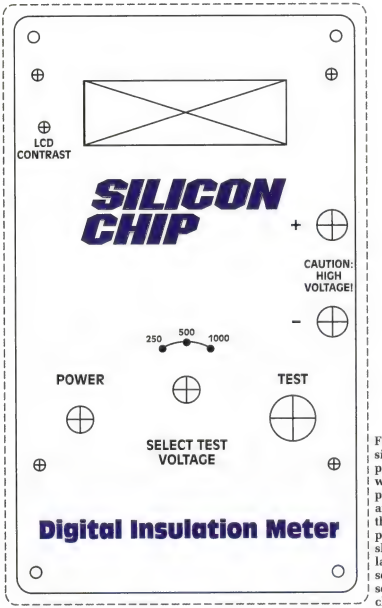


Fig.5: same-size front panel artwork which can be photocopied and glued to the panel. For protection, it should first be laminated or sealed with self-adhesive clear plastic.

position, at the negative spring end. The end of the spring is then carefully bent inwards and around in a circle, so that it can be held in place using a 6mm long M3 machine screw and nut, which will also attach the negative lead connection lug on the outside.

The converted battery holder can now be fitted inside the main section of the box behind the converter board, with the connection lead side to the left. Mount it using double-sided adhesive foam as mentioned earlier.

The box lid needs several holes drilled, plus a rectangular cutout near the upper end for the LCD. The location and dimensions of all these holes are shown in Fig.5, which can also be used (or a photocopy of it) as a drilling template. The 12mm hole for S2 and the 9mm holes for the test terminals are easily made by drilling them first with a 7mm twist drill and then enlarging them to size carefully using a tapered reamer.

The easiest way to make the rectangular LCD window is to drill a series of closely-spaced 3mm holes around just inside the hole outline and then cut between the holes using a sharp chisel or hobby knife. Then the sides of the hole can be smoothed using small needle files.

We have prepared an artwork for the front panel which be either photocopied from the magazine (Fig.5) or downloaded as a PDF file from our website and then printed out. The resulting copy can be attached to the front of the lid and then covered with

Insulation Testing

Testing the insulation of mains-powered equipment and cables is an important step in ensuring that they are safe to use and don't pose a shock hazard.

According to the Australian and New Zealand standards for safety inspection and testing of electrical equipment (AS/NZS 3760:2003), tests on the insulation of 'domestic' cables and equipment operating from 230V AC should be carried out with a testing voltage of 500V DC.

However where the equipment includes MOV surge protection devices, the testing can be carried out with a voltage of 250V DC.

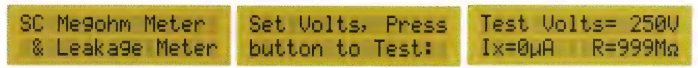
The recommended testing voltage for insulation tests on industrial equipment such as ovens, motors and power converters operating from three-phase 400V AC is 1000V DC.

Insulation tests on domestic 230V equipment can be performed by measuring either the leakage current or the insulation resistance.

For Class I (earthed) equipment with accessible earthed metal parts, the leakage current should be no greater than 5mA, except for portable RCDs (residual current devices) where it should not be greater than 2.5mA. The insulation resistance for these devices should be not less than 1MΩ or not less than 100kΩ for a portable RCD.

For Class II (double insulated) equipment, the insulation resistance with the power switch 'on' measured between the live supply conductors (connected together) and external unearthed metal parts should again be not less than 1MΩ.

The same insulation resistance figure of 1MΩ applies to extension cables and power boards (between the live conductors and the earth conductor), to power packs (between the live input pins and both output connections), portable isolation transformers (between the primary winding and external earthed or unearthed metal parts, between primary and secondary windings, and also between the secondary winding and external earthed or unearthed metal parts).



The three LCD screens which should greet you when you turn the Digital Insulation Tester on. The one on the left is self explanatory. It changes automatically to the middle one, which tells you what to do (it's not rocket science). The right screen shows the test voltage (as set by S1), the leakage current (in this case zero – bewdy!) and the measured resistance.

self-adhesive clear film for protection against finger grease, etc.

(A more robust alternative is to hot-laminate the paper panel in a clear pouch, cut it to size and then attach it using thin double-sided tape.)

You might also like to attach a 60 x 30mm rectangle of 1-2mm thick clear plastic behind the LCD viewing window, to protect the LCD from dirt and physical damage. The 'window pane' can be attached to the rear of the lid using either adhesive tape or epoxy cement.

Once your lid/front panel is finished, you can mount switches S2 and S3 on it using the nuts and washers supplied with them. These can be followed by the binding posts used as the meter's test terminals. Tighten the binding post mounting nuts quite firmly, to make sure that they don't come loose with use. Then use each post's second nut to attach a 4mm solder lug, together with a 4mm lock-washer to make sure these don't work loose either.

Now you can turn the lid assembly over and solder 'extension wires' to the connection lugs of the three switches, and also to the solder lugs fitted to the rear of the binding posts. These wires should all be about 30mm long and cut from tinned copper wire (about 0.7mm diameter).

Once all of the wires are attached, they should be dressed vertical to the lid/panel so they'll mate with the corresponding holes in the main PC board when the two are combined.

You should now be ready for the only slightly fiddly part of the assembly operation: attaching the main PC board assembly to the rear of the lid/front panel.

This is only fiddly because you have to line up the extension wires from switches S2, S3 and the two test terminals with their matching holes in the PC board, as you bring the lid and board together. This is not too difficult though, so just take your time and the lid will soon be resting on the tops of the board mounting spacers. Then you can secure the two together using four 6mm long machine screws.

Then it's a matter of turning the complete assembly over and soldering each of the switch and terminal extension wires to their board pads. Once they are all soldered you can clip off the excess wire with side-cutters.

The final assembly step is fitting the four wires used to make the interconnections between the two PC boards, and also soldering the ends of the battery holder leads to the terminal pins on the lower end of the main board. The interconnecting lead connections are shown clearly in Fig.3, but there are two points which should be stressed. One is that while light-duty insulated hookup wire (even rainbow cable, which we used) is fine for the three low voltage leads (+9V, GND and Vb), you'll need to use wire with mains-rated insulation for the high voltage lead.

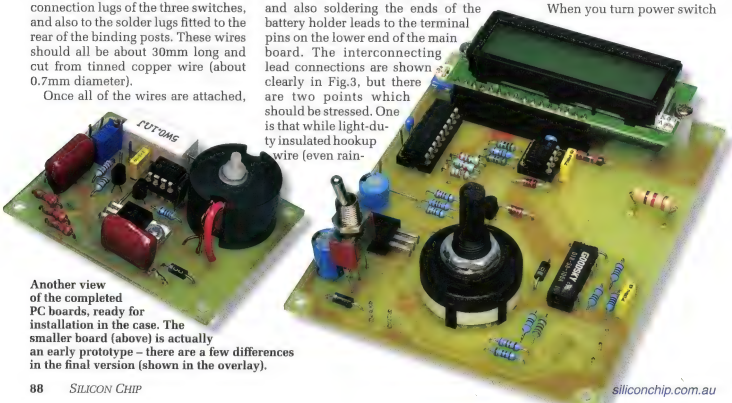
The second point is that although this is not shown in Fig.3 for clarity, all four of the interconnecting leads are run underneath the main board, and connect to it on the copper side.

Note too that although the high voltage lead connects to a terminal pin on the converter board, it solders directly to the board copper at the main board end. A terminal pin can't be used here, because it would protrude down too far when everything is assembled (and risk flashover to one of the cells in the battery holder).

Once the interconnecting leads and battery leads have been fitted, your new Digital Insulation Meter is almost ready for its initial checkout. All that remains is to make sure S3 is in the Off position and then fit six AA-size alkaline (or lithium) cells into the battery holder.

Initial checkout

When you turn power switch



Another view of the completed PC boards, ready for installation in the case. The smaller board (above) is actually an early prototype – there are a few differences in the final version (shown in the overlay).

siliconchip.com.au

What the PIC firmware does . . .

When power is turned on via S3, the PIC firmware 'starts work' by turning on RLY1 via Q4, to ensure that the metering circuit is set for the higher current range. It also initialises the LCD module, and then displays an initial greeting message on it to show that the meter is 'active'.

After pausing a few seconds it then displays a second message, advising the user to first set the test voltage (via S1) and then press the Test button (S2) to start testing.

As soon as it senses (via RA4) that the Test button has been pressed, it first checks the test voltage you have selected using S1. (It does this by checking the logic levels on RA0 and RA7.) Then it directs the PIC's ADC module to make a sequence of 10 measurements of the voltage applied to the AN2 input (which is the voltage across the 100Ω leakage current shunt, amplified by IC2a).

After taking the 10 measurements, it then works out the average of these measurements by calculating their sum and then dividing by 10. This averaging is done to give more steady readings, because the individual measurements tend to vary as a result of 'ripple' on the output of the DC-DC converter.

This average of the 10 measurements is then checked to see if it is a 'full scale' reading, and if so the firmware checks to determine the meter's current range setting.

If it isn't set for the higher current range, the meter is switched to the higher current range and the firmware loops back to take another sequence of 10 measurements, and work out their average.

If the average reading was not a full-scale one, or if it is already set for the higher current range, the firmware then does another check to see if the reading is below 10% of full scale. If this is so, it checks to see if the meter is switched to the lower current range.

If not, the meter is switched to the lower current range and the firmware loops back once again to take another sequence of 10 measurements and work out their average.

By doing this automatic range changing, the firmware finally achieves an average reading with the best resolution it is able to provide.

This reading is then processed by the firmware and its 24-bit floating point maths routines to calculate both the leakage current (in mA or μA) and the equivalent leakage resistance in megohms.

These calculated values are then displayed on the LCD screen, along with the test voltage being used.

One further little job done by the firmware is to check the values being displayed for current and leakage resistance, and if there are any 'leading zeroes' they are changed into blanks. This is another improvement over the firmware in the first version.

S3 on, a reassuring glow should appear from the LCD display window – from the LCD module's back-lighting. You may also be able to see the Meter's initial greeting 'screen', as shown in one of the display photos at right.

If not, adjust contrast trimpot VR2 with a tiny screwdriver until you get a clearly visible display. (VR2 is adjusted through the small hole just to the left of the LCD window.)

After a few seconds, the display should change to the Meter's measurement guide 'screen', where it reminds you to first set the test voltage using S1 and then press button S2 to perform the test.

As soon as you do press the test button, the display should change into the Meter's test result 'screen', where it displays the test voltage plus the measured leakage current and resistance. At this stage it will show a leakage current of 0μA and a resistance of 999MΩ because you haven't connected anything between the two test terminals to draw any current.

Now try switching voltage selector switch S1 to the other positions. When you then press and hold down S2 you should find that the test voltage setting displayed on the top line of the LCD screen changes to match.

If this occurs it will show that your Digital Insulation Meter is working correctly.

Setting the test voltage

If everything seems OK at this stage, it's time to do the final adjustment: setting the test voltage levels. This is easy enough to do because it simply involves monitoring the DC-DC converter's output voltage on a single range with your DMM, while carefully adjusting trimpot VR1 using a long and narrow insulated screwdriver.

Here's the procedure: first turn off the power to the Digital Insulation Meter using S3. Then swing up the lid and main board assembly to allow you to access the DC-DC converter board.

Next connect the DMM's positive lead to the "+HV out" terminal pin at the rear of the converter board just above D3 and connect the DMM's negative lead to one of the two 'earth' terminal pins of the same board. The TPG pin just above TP3 may be easier to access, but you can use the centre (GND) pin on the right-hand end of the board if you prefer.

Now turn the DMM on, and select the 500V DC range (or higher). Then turn on the meter using S3, switch S1 to its '250V' position and then carefully press and hold down S2 and the DMM reading should be around 250V. Then adjust trimpot VR1 to give a reading of 225V.

By doing this, the resultant test voltage across a 1MΩ load should be very close to the setting.

Alternatively, if you envisage testing equipment with internal MOVs, etc and possibly portable RCDs, do the voltage adjustment on the 250V range. In this case, adjust trimpot VR1 to give a reading of 265V. This will result in a test voltage across a 100kΩ load of close to 250V.

(Those pedantic readers who have very accurate DMMs may prefer to make the adjustment to 262V but the resulting test voltage will still depend on the overall resistor tolerances.)

Either way, you only have to adjust VR1 on one range as the other ranges will be pretty close to their nominal values.

Once you are satisfied with the voltage adjustment, you can turn off the power via S3, remove your DMM measuring leads and refit the lid assembly into the box.

You can then fit the screws which hold the lid and box together and your Digital Insulation Meter is now ready for use. SC

Vintage Radio

Automatic gain control (AGC): what it is and why it's necessary; Pt.2

The Healing 403E is a 4-valve superhet receiver with simple AGC. However, only about one third of the available AGC voltage is applied to the converter and IF amplifier valves, presumably to achieve an adequate audio output level.

In Pt.1, we looked at the origins of automatic gain control (AGC) systems and described some of the techniques that have been used over the years. This month, we look at simple, delayed, quiet and amplified AGC systems and describe some common faults in these circuits.

SOME OF THE AGC methods described in Pt.1 are still used extensively in domestic radio receivers while others have gone by the wayside. However, although the advantages of AGC were recognised and enthusiastically embraced by some manufacturers during the mid-1930s, many others neglected to use this very useful feature.

In fact, many receivers lacked an AGC system even into the 1950s.

One explanation for this is that some small (and not so small) manufacturers didn't employ design engineers but just copied the work of others. In addition, some design engineers really didn't understand how AGC worked or they thought that faults in the AGC system would be difficult to find and so left it out. Certainly, AGC faults were not easy to find in the early days, as will be explained later on.

Another reason for omitting AGC was the cost of the extra parts. This explains why AGC was omitted in so many "economy" receivers, especially the 4-valve types designed for the bottom end of the market.

Simple AGC

As the name implies, simple AGC is easy to implement. In fact, it can involve adding just two inexpensive parts to a receiver.

A common method of reducing the gain in a receiver with no AGC is shown in Fig.1. It involves increasing the cathode bias on the converter and IF valves while simultaneously progressively shunting the antenna input to ground using potentiometer VR1.

Conversely, to increase the volume, VR1 is wound the other way. This decreases the cathode bias while increasing the resistance between the antenna and ground. Indeed, this system works well as a manual gain control.

Usually, there was no volume control at the output of the detector as the volume control at the front end of the receiver was adequate. The RF and IF valves were generally remote cut-off types, so that smooth control of the volume was achieved.

Refer now to Fig.2. This shows a simple AGC system as used in many receivers. The differences between it and the circuit shown in Fig.1 are relatively minor.

In this case, potentiometer VR1 has been removed and the cathode circuits of both the converter and the IF amplifier are earthed via fixed resistors. The bottom ("earthy") end of the tuned antenna winding is now earthed at RF via a capacitor of around 47nF, as is the "earthy" end of the grid winding of the IF amplifier valve. A 1-2MΩ resistor is then wired back to the detector load and the AGC circuit is complete.

Basically, just a few extra inexpensive components were needed to upgrade the receiver with AGC. However, depending on the physical layout and other aspects of their design, some receivers used an additional RC circuit in the AGC system.

In some 4-valve sets, like the Healing 403E, where the total gain is relatively low (particularly in the audio section), the full AGC voltage is not applied to the controlled valves. This reduction in applied AGC voltage is achieved using a resistive voltage divider across the AGC line. By doing this, the audio output from the detector can be kept quite high, ensuring that it is adequate to drive the audio amplifier stage. However, it does have the disadvantage that the intermediate frequency (IF) stage could be overloaded by nearby strong stations.

This can occur if there is insufficient AGC voltage being developed to reduce the signal from the converter to a level that the IF amplifier can comfortably handle.

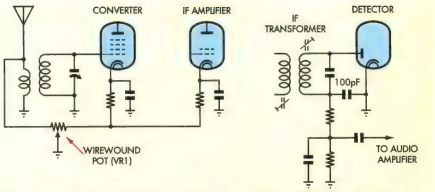


Fig.1: a common method of reducing the gain in a receiver with no AGC. It involves using VR1 to increase the cathode bias on the converter and IF valves while progressively shunting the antenna input to ground

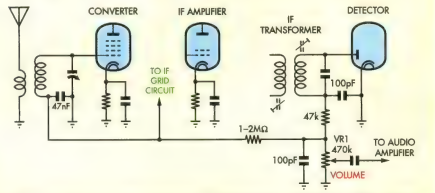


Fig.2: a simple AGC system. The gain of the converter & IF amplifier stages is automatically controlled by connecting a 1-2MΩ resistor between the grid circuits of the converter and IF amplifier valves and the detector load. VR1 then functions simply as an audio stage volume control.

Delayed AGC

As explained in Pt.1, delayed AGC (DAGC) involves delaying the application of the control voltage until the signal strength reaches a predetermined level. This is an improvement on simple AGC because it means that the receiver can operate at full gain on weak signals. The AGC cuts in only on stronger signals, when it's needed.

So how much more complicated is delayed AGC than simple AGC? In some cases, the circuits are quite complex but usually only a couple of extra parts are required.

Some circuits also apply differing amounts of AGC to the RF valves. For example, in a 6-valve set, the RF amplifier may initially receive no control voltage until the signal is at a moderate level while another stage (usually the IF stage) may receive most of the control voltage. Then, as the signal increases further, the AGC voltage applied to the first valve may increase dramatically but vary only slightly for the IF stage.

That's because the latter must be able to handle a strong signal in all situations.

In many receivers with two IF stages, the second IF stage has normal bias applied and is not connected to the AGC circuit. This is intended to ensure optimum noise figures and overload characteristics. Many converter valves, such as the 6BE6, are notoriously noisy and if the RF stage gain is throttled back immediately the DAGC threshold is reached, noise would intrude into the received signal.

Another variation often occurs with multi-band receivers. In these sets, AGC may be applied to the converter on the broadcast band but may be omitted on shortwave bands. This is done to ensure good frequency stability of the local oscillator.

Typical DAGC circuit

Most run-of-the-mill delayed AGC systems are relatively simple. Fig.3 shows a circuit with a delayed AGC system that was common from the late 1930s through to the early 1950s.

As shown, the detector circuit is quite conventional. The detector return circuit goes to the cathode of the duo-diode-triode, whereas the AGC diode load is tied to chassis so that its plate is negative with respect to the cathode.

This means that the signal level that's applied to the AGC circuit must exceed the cathode bias of the triode section of the valve before AGC action occurs. Once this level is exceeded, a negative control bias is applied to the AGC line.

The controlled valves are normally biased via bypassed cathode resistors. Note that the take-off point for the AGC diode is the same point as for the detector.

A variant of this circuit applies a positive voltage to the AGC line in the absence of signal. However, the cathode bias of the controlled valves

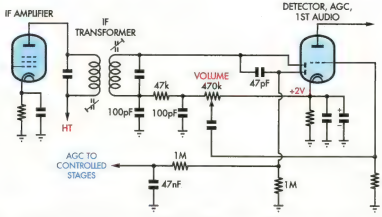


Fig.3: a circuit with a delayed AGC (DAGC) system. The detector circuit is quite conventional, whereas the AGC diode load is tied to chassis so that its plate (anode) is biased negative with respect to the cathode. This type of circuit was common from the late 1930s through to the early 1950s.

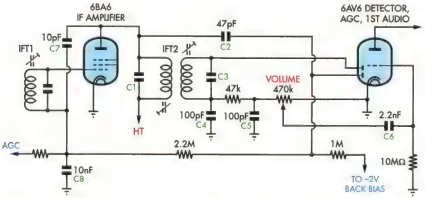


Fig.4: this simplified delayed AGC circuit relies on a -2V to -3V back bias which is obtained from the power supply. Bias for the triode amplifier is obtained from contact potential bias across the 10MΩ resistor.

is greater, so the net effect is that the valves do have negative bias. As the AGC circuit starts to operate, the positive voltage on the AGC line decreases and eventually becomes negative with strong signals.

This one could catch you out, as we usually expect the AGC line to be negative with respect to the chassis at all times.

An even simpler delayed AGC system relies on the back-bias networks that were fitted to later valve receivers – see Fig.4. This is similar to that shown in Fig.3 but there are a few important differences.

First, the duo-diode-triode (eg, 6AV6) has its cathode earthed and the bias for the triode amplifier is obtained from contact potential bias across the 10MΩ resistor (due to the electrostatic field from the plate). Back bias is obtained from the power supply and is usually between -2V and -3V. This is set so that the RF stages are operating at their optimum bias level. It saves at least two cathode bias resistors and their associated bypass capacitors, as the cathodes of the RF valves can now be connected directly to chassis.

As a result, in this circuit, there is always bias on the AGC line whereas the circuit in Fig.3 starts from 0V. When the signal level at the AGC diode exceeds the back bias level, the negative voltage increases and controls the gain of the receiver.

Note that the take-off point for the AGC diode is from the plate circuit of the IF amplifier (ie, following via C2) and not from the secondary of the IF transformer. This has a couple of advantages.

First, the signal level at the plate of the IF amplifier valve is higher than at the output of the IF transformer, which means that a greater AGC voltage can be developed. This is necessary in some receivers. For example, I converted an HMV Little Nipper to 32V operation a number of years ago. This meant that it had only 32V on the plates and its output was initially quite distorted due to the fact that the IF amplifier stage was easily overloaded with such low HT voltage.

The cure for this overloading was to convert its AGC system to the scheme shown in Fig.4.

The second advantage of the method shown in Fig.4 is improved AGC response as the receiver is tuned. By way of explanation, each tuned circuit in the IF amplifier chain increases the selectivity to the receiver. The more tuned circuits, the greater the selectivity.

By the time it reaches the detector, the 455kHz IF signal has been through four tuned circuits and so the selectivity will be quite high (ie, only the tuned station will be heard).

By contrast, the selectivity at the plate of the IF amplifier will be well down, which means that adjacent station signal strengths will also be quite high. However, this is exactly where the signal is picked off for the AGC diode.

At first glance this may appear to be a disadvantage but it actually improves the AGC action. What happens is that the AGC remains at a much more constant level as the receiver is tuned from station to station, due to the lack of selectivity at this point. As a result, this eliminates any momentary increase in volume as the desired station is tuned, since the AGC bypass capacitor is already charged and supplying the correct AGC voltage for that station.

All in all, it's a simple and nifty innovation.

Delayed AGC was achieved quite easily with some of the older duo-diode-triode/pentode 2V filament valves. They had a diode at each end of the 2V filament, one of which was used as the detector diode and the other as the AGC diode. A few examples of these valves are the 1B5, 1F7G, 1H6G, 1K6 and 1K7.

Quiet AGC

Although not particularly successful in domestic radio receivers, quiet AGC (QAGC) was originally developed to "mute" the sound when tuning between stations. It typically consists of a diode in the audio signal path which is biased so that it doesn't conduct

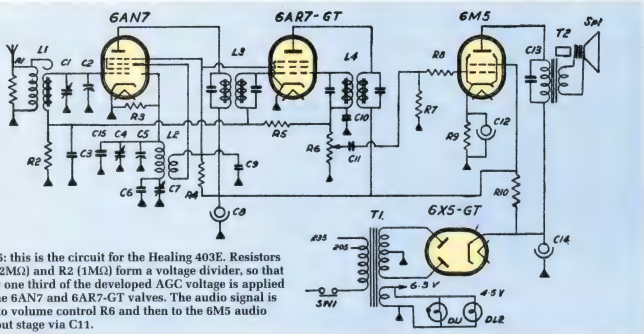


Fig.5: this is the circuit for the Healing 403E. Resistors R5 (2MΩ) and R2 (1MΩ) form a voltage divider, so that only one third of the developed AGC voltage is applied to the 6AN7 and 6AR7-GT valves. The audio signal is fed to volume control R6 and then to the 6M5 audio output stage via C11.

until the AGC voltage rises above a particular threshold. Alternatively, it can be wired across the signal path to earth so that it shunts most of the signal until a preset level of AGC bias is applied. When that happens, it stops conducting and the signal can pass through to the next stage as normal.

Another method is to apply a manually-adjustable voltage to bias off a sharp cut-off audio valve. A separate AGC-type detector is then used to produce a positive voltage when a station is tuned. This swamps the negative bias voltage and turns the valve on so that the audio amplifier operates normally.

Yet another version uses a detector with an adjustable bias. When the incoming signal exceeds a critical level, the diode is biased on and is able to detect the signal which is then fed to the audio output stages.

One of the annoying features of QAGC is considerable distortion in the audio for signals that are just above the critical switching level. This was one of the main reasons that QAGC didn't enjoy widespread popularity. However, the problems inherent with QAGC were largely overcome in later transistorised communications receivers.

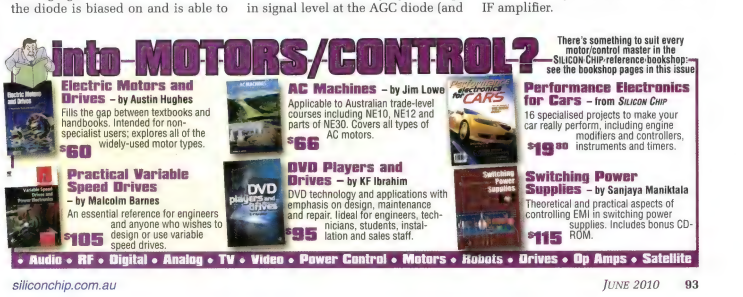
Audio AGC

Although AGC and particularly DAGC systems do keep the audio output reasonably constant for different signal strengths, stronger stations do produce stronger signals at the detector. After all, it is only by a change in signal level at the AGC diode (and detector) that a change in the AGC control voltage is achieved.

However, it is possible to make the audio output from all stations approximately the same, even at high signal strengths. This can be achieved by feeding a portion of the developed AGC voltage to a remote cut-off valve like a 6U7G. This is the first audio valve in sets like the HMV 668 and about one third of the developed AGC voltage is applied to this valve.

Reflex receivers

Reflex receivers usually use a single valve as both the IF amplifier and the first audio stage. It is necessary to be cautious in applying AGC to such a stage, as the operating conditions can be more stringent than for a straight IF amplifier.



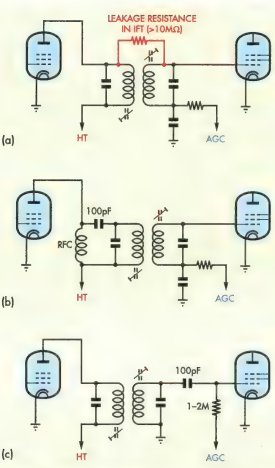


Fig.6: excess leakage between the primary and secondary windings of an IF transformer as shown at (a) can cause serious AGC problems in a receiver. Altering the circuit configuration to that shown in either (b) or (c) fixes the problem by making transformer leakage irrelevant.

In addition, if AGC is applied to this stage, it operates at both IF and audio frequencies. So it does, in fact, have audio AGC as described in the previous section.

Amplified AGC

Amplified AGC generally involves adding an additional IF stage just to feed the AGC diode. As a result, the AGC diode receives a much larger signal than the detector diode and this in turn gives a much larger AGC voltage range to control the RF valves in the front end.

Another method is to use either the first audio valve or a separate valve to amplify the AGC DC voltage. My own preference, however, is to use audio AGC, as described previously.

AGC component values

AGC component values are not usually overly critical although it is best to stick with the values shown on the circuit (or as close as possible to them).

In some HMV circuits, the AGC bypass capacitor is fairly critical, as it is used in a bridge circuit to neutralise the 6BA6 in the IF amplifier. The basic circuit is as shown in Fig.4. As an aside, I restored one of these sets in which bypass capacitor C8 had been increased 10-fold in value. The receiver was unstable because the neutralisation had been upset.

AGC faults

In early days, AGC faults were considered difficult to find. There were several reasons for this:

(1) Most radio technicians were initially unfamiliar with AGC circuits and didn't understand how they worked. Servicemen were usually self-trained and rumour had it that AGC faults were difficult to fix;

(2) AGC circuits have quite high impedances and most servicemen had only a few screwdrivers and spanners, a "calibrated finger" to test grid circuits and a 1000Ω/V meter. In use, a 1000Ω/V multimeter would load the AGC line so much as to make measurements useless. AGC bypass capacitor leakage couldn't be easily tested either; and

(3) The paper capacitors used in AGC circuits in the early days were often leaky almost from new.

All of the above factors conspired to convince servicemen that AGC circuits were hard to service.

By contrast, modern digital multimeters typically have an input impedance of 10MΩ or more and these make it easy to service AGC circuits. It's easy to accurately measure the AGC voltage at the capacitor and on the other side of the AGC resistor and determine which part is at fault. In addition, good quality resistors and modern polyester and ceramic capacitors mean the AGC circuits are now extremely reliable.

However, early AGC circuits could be troublesome and there were several common faults. For example, a leaky AGC bypass capacitor can cause the set to distort badly on strong signals and the volume to vary quite markedly as the set is tuned from station to station.

AGC lead routing

One thing to be careful of when restoring early sets is AGC lead routing. There can be quite high levels of IF energy on these leads following the AGC diode and this can interfere with the AGC action if the leads are incorrectly routed.

Some time ago, I had a peculiar fault in a high-performance valve receiver. If relatively weak stations were tuned, it was possible to advance the volume control to obtain quite good volume. However, on strong stations, I found that the volume decreased as I increased the volume control until eventually, there was no audio output at all!

Fig.4 shows the relevant circuit section. In this case, audio coupler C6 proved to be quite leaky. Because the triode audio valve has such a high grid resistor (ie, 10MΩ) and the contact potential bias is around 0.5-1V, the valve was soon cut off with a high DC output from the detector. The capacitor was replaced and the set then performed normally.

Although capacitors caused most AGC faults, leakage between plate and grid windings will also upset an AGC

network. This sort of problem is rare but can be difficult to fix if it does happen because a replacement coil may not be available.

One possible way around this is to alter the circuit configuration shown in Fig.6(a) to the configuration shown in either Fig.6(b) or Fig.6(c). Doing this makes any leakage in the winding largely irrelevant.

By the way, the mica capacitor depicted as C2 in Fig.4 should be replaced if strange things are happening in the AGC circuit. These capacitors can sometimes become leaky.

Check the valves

Don't cross valves off the list of items that can cause problems with AGC circuits. They can become gassy or have low gain and emission. If in doubt, try a new valve.

AGC may be applied to the control grid of valves either through the lower end of the tuned winding or via an RC network as shown in Fig.6(a). And as mentioned earlier, this can cause problems if there is too much leakage between windings.

Usually, variable mu (remote cut-off) valves are used in receiver stages that are controlled by AGC but some receivers use sharp cut-off valves in their IF stage(s). Sharp cut-off valves can be used with AGC but usually in conjunction with a variable mu valve. Only a small fraction of the AGC voltage is applied to the sharp cut-off valve while the variable-mu valve receives the full AGC voltage.

The negative cut-off voltage can sometimes be extended from say -5V to about -10V by feeding the screen via a high-value resistor with the maximum voltage that the power supply can provide. As the valve begins drawing less current with increased AGC voltage, the screen voltage rises and this extends the cut-off voltage.

Summary

Most early AGC circuits work quite well but some were not particularly well designed, despite the fact that efficient AGC systems are not all that complicated. In addition, many otherwise competent vintage radio restorers have trouble diagnosing problems in AGC circuits. However, by understanding how these circuits function and by using modern test equipment, tracking down AGC faults is usually quite straightforward. SC

Photo Gallery: Airzone Symphony Leader

THE AIRZONE SYMPHONY Leader, circa 1939, was a 5-valve superhet receiver in a large tombstone-style bakelite case. It featured a large round dial and, on shortwave versions, this changed colour from amber to green when the set was switched from AM to shortwave. The valve line-up is 5Y3, 6V6G, 6B6, 6U7 & 6A8. Photograph by Kevin Poulter for the Historical Radio Society of Australia (HRSA). Phone (03) 9539 1117. **www.hrsa.net.au**

Solar-Powered Lighting System

Last month we described the operation of our new off-grid lighting system, featuring free power courtesy of the sun! Now we move on to the fun part: building it!

Part 2 – By JOHN CLARKE

We're confident that this will be a ***very*** popular project, offering far more features than typical "solar chargers".

One thing we didn't mention last month is that being all low-voltage, it would make a perfect school electronics project. And the fact that it is decidedly "green" will bring a warm glow to any environmentalist teacher's heart!

To fully understand the project, you will need to refer to the detailed explanation given in Part 1 (May). It also contains the circuit diagram which you might need to refer to during construction.

The controller is built on a PC board coded 16105101, measuring 133 x 86mm. This PC board is designed to be housed in a 157 x 95 x 53mm utility box (size UB1), clipping into the integral mounting slots moulded in the side of the case.

Begin construction by checking the PC board for breaks in tracks or shorts between tracks and pads. Repair if necessary. Next, check the hole sizes are correct for each component. The screw terminal holes are 1.25mm in diameter compared to the 0.9mm holes for the ICs, resistors and diodes.

Assembly can begin by inserting the links and the smaller resistors. When inserting the resistors, use the resistor colour code table to help in reading the resistor values. A digital multimeter can also be used to confirm the values, especially where close colours might be misleading. We used tinned copper wire for the links although 0Ω resistors may be supplied in kits. These look like small resistors but have just one black stripe around their body.

As mentioned last month, resistor R2 (100kΩ) is only installed if a standard PIR detector is to be used. It is left out if the recommended (Altronics) PIR is used.

Next are the diodes, mounted with the orientation as shown on the overlay. Don't mix up the Zener diodes and ordinary diodes. Now is a logical time to solder in the PC stakes and the 3-way headers for LK1 and LK2 and 2-way pin header for TP3 and TP4.

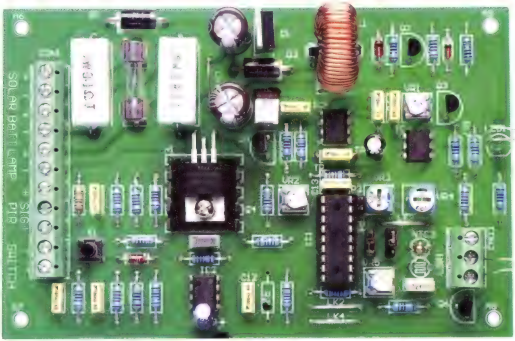
IC1 is mounted on a DIP18 IC socket. Solder in the socket (with the notch in the direction shown) but at this stage, don't plug in the IC: it's left out until the 5V supply is adjusted. The remaining ICs can either be mounted using sockets or mounted directly on the PC board. Ensure each IC is placed in its correct position and is oriented correctly, with the notch (or pin 1 indicating dot oriented) as shown.

When you solder the fuse clips in, you'll see they have an end stop or small lugs to prevent the fuse sliding out. The lugs need to be to the outer ends of the fuse – if soldered in back to front the fuse won't go in.

The 0.1Ω 5W resistor can be mounted now. The value of resistor R1 needs to chosen according to the lamp or lamps used. For more detail see Table 2.

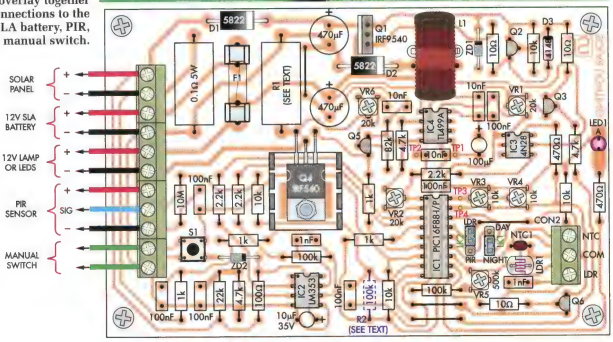
Next are the trimpots –again, take care to place the correct value in each position. Note that most trimpots are marked with a code rather than the actual ohm value. For the 10kΩ trimpots, the marking may be 103, the 20kΩ trimpots 203 and the 500kΩ trimpot 504.

Install the transistors and Mosfets taking care not to confuse Q2, Q3 and Q5 (all BC337 types) with Q6 (a 2N7000). Also, ensure that Q1 is the IRF9540. Mosfet Q4 is the IRF540 and is mounted horizontally on the PC board using a small heatsink. The leads are bent at 90° before inserted into the PC board. It's easiest to fasten Q4 to its heatsink and the PC board with its screw and not *before* soldering it in place to ensure that it lines up with the screw hole in the PC board.



Same-size photo of the completed PC board. As you can see here, both the LDR and LED can be mounted on the board (the LDR via CON2) and bent over 90° to line up with holes in the case.

Fig.6 (below) matches this photo and shows the component overlay together with the connections to the solar panel, SLA battery, PIR, LEDs and manual switch.



The 11-way terminals are made using three 3-way and one 2-way section which dovetail together before installing onto the PC board. The wire (entry) side faces the outside of the PC board.

S1 can be installed now followed by LED1, which is mounted so the top is about 25mm above the PC board. Ensure the anode (the longer lead) goes into the hole marked "A". The coil, L1, is mounted upright and secured to the PC board with a cable tie as well as being soldered (see the photo and diagram above).

Finally, the LDR can be installed. If you use a clear-lid UB1 box to house the Solar Lighting Controller you may be able to install LDR1 directly onto the PC board. Where the lid is not clear, or if the box will not be exposed to ambient light, the LDR can be fastened to the CON2 connector terminals so that it "sees" through a hole in the side of the box. As we mentioned last month, it can be remotely located using figure-8 wire. Note that it is either on the PC board or remote, not both! LDRs are not polarised.

Similarly, the NTC can be installed on the PC board or remotely, using a figure-8 cable connection for external temperature sensing of the battery.

Setting Up

Links LK1 and LK2 need a jumper shunt, with the various options shown in Table 1. If you are not sure at the moment, take a guess: they can be readily altered later on.

With IC1 still out of circuit, but the fuse in place, apply power to the '12V SLA Battery' + and – inputs on connector CON1. With a DMM, measure the voltage between pins 5 and 14 of IC1 and adjust VR1 for a reading of 5.0V.

Now switch off power and place IC1 in position, taking care to insert it correctly: the right way around and no pins bent out of position. Apply power again and measure the

Table 1: Lamp Operation

PIR (LK1)	LDR (LK2)	Lamp ON	Lamp OFF
In	Night	PIR movement detection or with S1 during night time only	Timer timeout, S1 or at dawn
In	Day	PIR movement detection or with S1 during day time only	Timer timeout, S1 or at dusk
In	Night (LDR1 disconnected)	PIR movement detection or with S1 during day and night	Timer timeout or S1
Out	Night	Day to night transition or with S1, night only	Timer timeout, S1 or automatically at dawn
Out	Day	Night to day transition or with S1, day only	Timer timeout, S1 or automatically at dusk
Out	Night (LDR1 disconnected)	S1 during day or night	Timer timeout or S1

Table 1: reproduced from last month, this shows the various options available with the PIR link in and out and the LDR link (LK2) dark, light or disconnected.

voltage across the same (12V SLA battery) inputs. Multiply the measured voltage by 0.3125. For example, if the voltage is 12V, 0.3125 x 12V = 3.75V. Make a note of this figure.

Now you need to calibrate the battery voltage so that the 20°C cut-off voltage for the battery is 14.4V and the float voltage is 13.5V.

This is really easy: press **and hold down** switch S1 (otherwise the reading will be false) and connect your multimeter between TP1 and TP2 (with it set to read up to 20V). Adjust VR2 so that the reading equals this worked-out voltage you wrote down (ie, xV x 0.3125).

Setting the lamp current

As mentioned, the Solar Lighting Controller lamp driver can be set up to drive LEDs directly or low-power 12V lamps

Output current	200mA	350mA	500mA	700mA	1A	2A
R1 (all 5W)	3.3Ω	2.2Ω	1.5Ω	1Ω	0.68Ω	0.33Ω

Table 2: resistor (R1) value for constant current LED drive or for over current limiting.

TP4 Voltage	Timeout period	Timeout steps	Timeout calculation (approximately)
0V-2.5V	2s-250s (4m)	2 seconds	TP4 voltage x 100s
2.5V-4.9V	4m-480m (8h)	4 minutes	(TP4 Voltage-2.5V) x 200m
5V	No timeout		

Table 3: timeout adjustment using VR4. This is measured between TP4 and TP1 (ground) while S1 is pressed.

instead. Fig.7 shows some of the types of lighting that can connect to the Solar Lighting Controller.

12V lamp varieties could be compact fluorescent lamps (CFLs), halogen filament globes or LED globes. The distinction we are making between LEDs and 12V LED globes is that while 12V lamps can be directly driven from a 12V supply, standard LEDs cannot. This is because LEDs must have a current limited supply to prevent damage.

Some 12V LED globes use single or multiple LEDs in the one housing, which include some form of current limiting. 12V LED lighting may not very efficient because of losses, especially if they use simple current limiting resistors.

For example, a typical 5W LED MR-16 halogen light replacement may well drive the LED at 5W but the overall power used by the lamp is 7.2W. This represents a 2.2W or 31% loss (69% efficiency) in delivering power to the LED or LEDs. Note that this efficiency is not the amount of light output for a given power input, it is simply the power lost.

So while white LEDs are more efficient at producing more light for a given power than halogen lamps, the loss in the current limiting resistor for the LED may change this.

When using individual white LEDs directly, the Solar Lighting Controller is set to drive them at the required current. As an example, three star 1W LEDs would be driven at around 300 to 340mA and use a 2.2Ω resistor for R1. For three 3W LEDs the current is around 700mA and R1 is 1Ω instead.

Resistor Colour Codes

No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑ 1	10MΩ (5%)	brown black blue gold	N/A
❑ 2	100kΩ	brown black yellow brown	brown black black orange brown
❑ 1	82kΩ	grey red orange brown	grey red black red brown
❑ 2	22kΩ	red red orange brown	red red black red brown
❑ 4	10kΩ	brown black orange brown	brown black black red brown
❑ 3	4.7kΩ	yellow violet red brown	yellow violet black brown brown
❑ 2	2.2kΩ	red red red brown	red red black brown brown
❑ 3	1kΩ	brown black red brown	brown black black brown brown
❑ 2	470Ω	yellow violet brown brown	yellow violet black black brown
❑ 1	100Ω	brown black brown brown	brown black black black brown
❑ 3	10Ω	brown black black brown	brown black black gold brown

For 12V lighting, it may be more efficient to use a halogen 12V lamp such as the Altronics 12V bulkhead light (cat no X2400) instead.

Current adjustment over a small range is available using VR6. The easiest way to measure LED current is to connect a multimeter (on a DC current range) across the fuse clips with the fuse removed. The quiescent current drawn while the lamp is off can be subtracted from the total LED drive current for more accuracy.

If you require more than three LEDs, then a separate LED driver can be used that is designed to drive several LEDs in series from a 12V supply.

An example of a driver that can power up to six 1W-LEDs in series is the Altronics M3310. The setting up for the Solar Lighting Controller Lamp driver for use with a separate LED driver is the same as for standard 12V lighting where R1 is 0.33Ω.

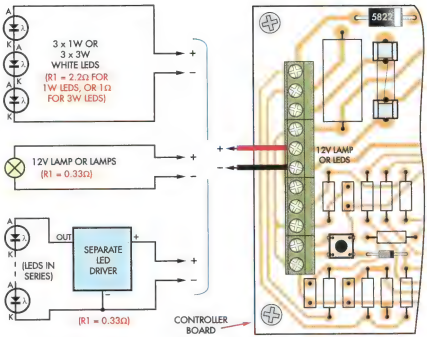


Fig.7: the Solar Lighting is designed to drive three 1W or three 3W LEDs in series or 12V lamps. Note the value for R1 is different for each lighting circuit. For more than three LEDs in series a separate driver is required.

Timeout

Depending on your application, the timer will need to be set to an appropriate period. Timeout periods can be adjusted from as low as two seconds up to about 8 hours using VR4.

Table 3 shows the timeout with respect to voltage, set by VR4. To measure this voltage, a multimeter is connected between TP1 and TP4 and the S1 switch is pressed. The measured voltage provides a means to calculate the expected timeout. For voltages up to 2.5V, the timeout period in ***seconds*** is calculated as the voltage measured (in volts) multiplied by 100. By way of example, a 1V setting will provide 100 seconds.

Above 2.5V, the voltage is multiplied by 200 ***minutes*** after first subtracting 2.5V from the voltage measurement. So a 3V reading will provide a timeout of (3V-2.5V) x 200m, or 100 minutes.

Temperature compensation for the cut-off and float voltage is set using VR3. The voltage can be measured between TP1 and TP3 while S1 is pressed. Compensation is adjustable from 0mV/°C to –50mV/°C. The actual compensation is directly related to the measured voltage. Just divide the voltage by 100 to get the mV/°C value. The actual compensation value required depends on the battery with manufacturers specifying this mV/°C value. Typically the value for a 12V battery is –19mV/°C. So VR3 would be set to 1.9V as measured at TP3.

Installation

The Solar Lighting Controller is designed to mount in a UB1 box with wires for the external connections passing through cable glands. The charge LED (LED1) is bent over and protrudes through a hole in the side of the box.

Fig.6 shows the wiring connections for the solar panel, the battery and the lamp plus the PIR and manual switch terminals at CON1 and the external NTC and external LDR at CON2. As noted the NTC and LDR can be mounted on the PC board ***or*** mounted remotely (ie, only one LDR and one NTC should be connected).

In most installations the NTC thermistor can be mounted on the PC board because the Solar Lighting Controller and battery would be housed close to each other and their temperatures would therefore be similar.

However, an external NTC, attached via a length of figure-8 wire and mounted against (glued or taped to?) the side of the battery, would be necessary if the battery is installed any distance from the Solar Lighting Controller.

Mounting the LDR

The LDR needs to be mounted so it receives ambient light but so that it does not receive light from the lamp/s controlled by the Solar Lighting Controller. For some installations, the LDR can be mounted inside on the PC board if you use a transparent box and if the Solar Lighting Controller is exposed to the ambient light.

Alternatively, the LDR can be mounted into CON1 and exposed to ambient light by having the LDR mounted into a hole in the side of the case.

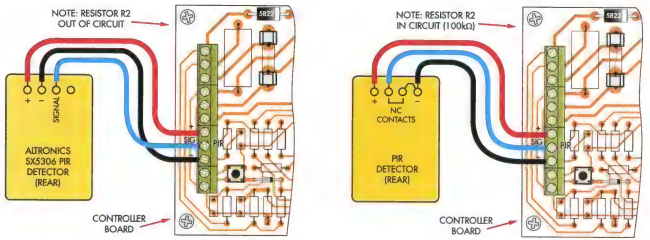
Where the Solar Lighting Controller is mounted inside a cabinet or other dark place, the LDR can be mounted using a length of figure-8 wire in a position where it will be exposed to ambient light.

Solar panel position

The solar panel should be mounted on a roof or similar position and in Australia should be set facing north. (Most of the references you see on the internet are for Northern

Capacitor Codes

Value	µF Value	EIA Code	IEC Code
100nF	0.1µF	100n	104
10n	.01µF	10n	103
1n	.001µF	1n0	102



(A) USING THE ALTRONICS SX5306 PIR DETECTOR

(B) USING A STANDARD PIR DETECTOR

Fig.8: this shows how to wire up a PIR detector to the Solar Lighting Controller. When using the Altronics SX5306 PIR Detector, the plus, minus power leads and the signal wire are connected to the controller as shown. R2 is not used on the controller PC board. For use with standard PIR Detectors. the minus supply is linked to one of the NC contacts on the PIR detector relay. The second contact of the NC contact becomes the trigger wire for the controller. Note that R2 needs to be soldered onto the controller PC board when using this standard type of PIR detector that uses a relay.

Hemisphere installations, where you would have the solar panel facing south).

Inclination should be roughly 23° up from horizontal for NSW, central/south WA and SA and the north island of NZ. Slightly higher angles are required for Victoria, Tasmania and NZ south island, while slightly lower angles will be needed for Qld, NT and northern WA. If in doubt, several internet sites will help you (but again, beware of northern hemisphere sites!).

Incidentally, many solar panels do not like to be partially shaded – we've seen reports that even a small percentage of shading reduces the output to near zero – so care should be taken to avoid any possibility of shadowing (eg, from a pole or tree) as the sun traverses the sky.

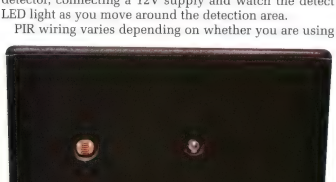
Mounting the PIR

When mounting the PIR sensor, its position should be placed to provide coverage of the desired detection area. You can test coverage by temporarily mounting the PIR detector, connecting a 12V supply and watch the detect LED light as you move around the detection area.

PIR wiring varies depending on whether you are using the (recommended!) special low-current Altronics PIR sensor or a standard PIR detector.

Fig.8 shows typical wiring for both of these types of PIRs. Note that R2 is not used for the Altronics PIR but it should be installed when a standard PIR detector is used. 4-way alarm cable is normally used for this wiring with only three of the wires used.

Most PIR units have a "tamper" detector of some sort which normally uses the fourth wire but in this case, the tamper detector can be ignored.



Looking end-on at the completed project showing both the LED and LDR inside the box, "seeing" through appropriately placed holes. If better water resistance was required (though not waterproofing) some clear film or plastic could be glued over the holes on the inside.

The lamp

We made up a LED lamp using three white LEDs and this was shown in the photographs last month. The lamp is wired in to the Solar Lighting Controller using figure-8 wire.

A LED light can be made using a clear plastic utility box or an IP65-rated box with a clear lid. This latter style of box is more suited to outside use where it must be waterproof. The LEDs require heatsinking, so are mounted onto an aluminium plate that sits inside the box. The IP65 box has integral mounting bosses for attaching the plate. A plastic utility box (the type we used to house the Controller) has integral (moulded) side clips for mounting the aluminium plate horizontally.

The LEDs are mounted onto the plate using Nylon screws and nuts. We used three 1W LEDs arranged in a triangle pattern onto the plate but as discussed earlier, 3W LEDs could be used instead.

The LEDs are wired in series and the wires taken out of the box via a cable gland (even though the gland is "waterproof", for outside use the box should be mounted so the gland emerges from the underside).

To spread the light more evenly, we cut a "diffuser" to fit inside the lid, made from a piece of translucent plastic – actually we used a kitchen cutting mat which was about 0.5mm thick and easily cut with scissors – but any suitable translucent plastic sheet could be used.

Finally, use crimp connectors for the wires connecting to the battery terminals. Never attempt to solder wires direct to the battery as this can cause irrepairable damage. SC

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Ignition for a Velocette motorcycle

I have bought the "Ignition Coil Driver", as featured in SILICON CHIP, March 2007. My intention is to use it between the existing points and coil on a motorcycle. The motorcycle is a 1950s British Velocette Valiant, with a 6V battery. Will the system work with 6V? (D. R., via email).

● The ignition coil driver can be used to directly fire ignition from a points trigger provided that the circuit in the April issue (p78) showing the "to invert firing sense circuit" (Fig.21) is built. A "points-wetting" resistor (eg, 33Ω 5W) should be placed between the input and 6V supply to allow current flow through the closed points.

Finally, the 100Ω 5W resistor at the collector of Q2 should be changed to 33Ω 5W for a 6V supply.

Using the zapper with the engine running

I am wondering if the 12V Battery Zapper unit (SILICON CHIP, July 2009) can be used with the vehicle's engine running? I don't have 240VAC available to run a charger. (S. F., via email).

● While engine control modules normally have spike voltage protection, it is probably not a good idea to run the Zapper in a car, whether the engine is running or not. In other words, the battery should be disconnected from the vehicle. We are assuming that this is a vehicle which is seldom used. If the car is used reasonably often, then you should not have a problem with sulphation.

On the other hand, if the vehicle is older, without an engine management computer, you can probably run the Battery Zapper on it with the engine running, without any risk of damage.

Digital TV dilemma

I am faced with a dilemma. I recently bought an AWA Standard Definition Digital Set-Top Box (Model No. DT 2030) but there appears to be no way I can connect it to my existing TV.

The set I have is an AWA with about a 25cm screen. It is a compact TV but works fine and displays a perfect picture. Like most older TVs, it only has a 75-ohm coax cable aerial socket. The STB has component video out, plus S-video and composite video out.

Oddly enough, it would probably work OK with an old Commodore computer monitor which had component video in (RGB). Some time back, there was an article in SILICON CHIP about a restored B & W valve TV set which worked fine with digital broadcasts, obviously using a STB. So there must be a way to interface both together.

I don't want a new TV, as the set I already have serves me well. One thought I had was to use an old VCR with composite video in/out. I could feed composite video in, then connect the VCR to the aerial socket on the TV. The problem is finding somewhere to put all this clutter, plus another 4-way power board just to watch digital TV on a standard definition set! Surely there must be a better way.

Apparently, my STB does not have an RF modulator like a VCR. I don't want to abandon an otherwise perfectly serviceable TV and my other option is to buy a cheap LCD TV but even some of these do not have an inbuilt tuner – you still need an STB.

Another possibility is to get a secondhand TV that has multiple inputs. I am quite sure that I am not the only one who is confused with all this Digital TV nonsense. Perhaps SILICON CHIP could do an article about the various set-top boxes available, so a person has some idea about the best

Updating The Studio 350 Amplifier Module

I was wondering if you are going to do an update on your Studio 350 Amplifier (SILICON CHIP, January & February 2004) to introduce the new design benefits (better PSRR, lower distortion etc) of the Ultra-LD Mk2 200W amplifier PC board topology (SILICON CHIP, August & September 2008).

Also, concerning the latter amplifier, I have many surplus 500VA transformers with 45V + 45V & 15V + 15V secondary windings. I would like to know if the module can handle the higher than specified (40V + 40V) supply voltages. They would be driving 3-4Ω loads; high-end dynamic drivers, not electrostatics or ribbons. Also what adjustments or parts would need changing?

If the transformers can't be used on the Ultra-LD, what would the Studio 350 lose by having a lower supply voltage? (S. W., KilKenny, SA).

● We have not given any thought to upgrading the Studio 350 to the Ultra-LD standard and nor is there any guarantee that a similar order of improvement would be possible, using the new power transistors. It would also be expensive.

Part of the problem is that the large number of output transistors in the Studio 350 makes it difficult to employ the same PC board topology to get the same cancellation of magnetic fields due to class-B currents.

We would not recommend a 45V power transformer for the Ultra-LD amplifier. It would exceed the voltage ratings on the power supply capacitors and would be pushing the transistor ratings, given that you want to drive 4Ω loads. On the other hand, if you used them for the Studio 350, you would lose very little power.

Schottky Diodes For Isolating NiMH Batteries

I have a radio-controlled model boat and the electronic speed controller requires 14.4V to operate and the motor draws 20A at full load.

I have two 7.2V 3300mAh NiMH batteries connected in series and I have read that you need to put a Schottky diode in each of the positive lines so that they do not back feed into each other. Would a Philips BAT82 rated at 30A & 50V be suitable or do I need something bigger? (A. D., via email).

● With two 7.2V batteries connected in series to obtain 14.4V, you do not need Schottky diodes. In fact, each 7.2V battery pack has six cells connected in series so by having two battery packs you are merely connecting 12 cells in series.

Diodes only need to be used if the batteries are connected in parallel (ie, positive terminal on one battery to positive on the other and negative on one battery to negative on the other) to obtain 7.2V but with greater capacity. The diodes then prevent one battery charging the other.

one to get to suit their needs. The one I bought cost less than $40 and is very compact. Now I am wondering if I should have bought a more expensive model or give up watching TV! (N. B., Canterbury, NSW).

● Your suggested solution of using the A/V inputs of a VCR for the connection is probably the cheapest. The only other alternative is to use an RF modulator such as one available from Jaycar, Cat LM-3872 (mono) for $18.95 or LM-3873 (stereo) for $24.95.

As far as we know, there are no STBs available with inbuilt RF modulators

However, we should point out that if you only have an SD (standard definition) set-top box, you will not be able to receive the HDTV channels. To get the HD channels, you need an HDTV set-top box to go with your analog TV. Also, by using such a small screen analog TV, you are definitely not getting the full advantage of the improved picture quality.

Self-test wanted for coolant level alarm

I have built and fitted Coolant Level Alarm kits into all my family cars since the kit was produced in 1994, as in the 1980's I destroyed an engine which had blown a radiator hose and drained the coolant.

My current car, a Nissan Maxima, has no water temperature gauge (only idiot lights which I consider a backward step) and the addition of the alarm at least gives me some sense of security.

My previous car, which was also fitted with a coolant alarm, blew the fuse supplying the alarm and as a consequence the alarm would not have worked due to no power. Apart from removing the probe connection occasionally, is there any way a self-test on engine start up could be easily added to the circuit? (F. W., via email).

● In its simplest form, a self-test could be just a normally closed pushbutton switch connected in series with the coolant sensor. Pushing the switch would simulate an open connection in the same way lack of water opens current flow.

For an automatic self-test, a timer could be added to open the connection via a relay for a short time when the ignition is first switched on. The timer could be the High Performance Timer that we published in "Performance Electronics for Cars". It is sold as a kit by Jaycar (**www.jaycar.com.au**) – kit number KC5379.

Capacitor leakage testing

The Capacitor Leakage Testers (SILICON CHIP, December 2009 & April 2010) attracted my attention as I have a requirement for such a device but with a bit more capability.

My requirement is to confirm that the leakage resistance of a .035µF capacitor when measured at 130V is not less than 50 Gigaohms. The measurement has to be taken in the field (ie, not in a controlled environment) and even on a wet day!

The Keithley CD on the subject goes so far as to suggest that one cannot even have a ceiling fan, as the rotating blades would modulate the outer metal case of the capacitor with the air disturbance and give rise to false readings. I currently have a test set capable of reading to 100MΩ and this becomes useless on a wet day.

Would you be able to offer any comment that would fill in the blank in my knowledge or assist in arguing the need to have such a high spec? The capacitor is used in a magneto and another similar magneto of another brand has a requirement for testing at 400V with an allowable leakage current of 8mA or 50kΩ!

The real problem is that the magnetos are used in old aircraft and all work carried out must be absolutely in accordance with the approved manual provided by the manufacturer. One of the popular magnetos is the SLICK brand, manufactured by Unison Industries, now owned by Champion. Our organisation operates under an approval from CASA (Civil Aviation Safety Authority).

I did approach CASA, only to be told that I was being pedantic. Clearly they had no idea of the reality of the requirement. The most amazing thing of all is that for some years now the global maintenance industry has been certifying that maintenance has been carried out **in accordance with** the manufacturer's manual and as far as I know, not a word has been said. (G. M., via email).

● No magneto should require a capacitor with such a high insulation resistance. In fact, that order of insulation resistance is much higher than for most plastic capacitors apart from those with polystyrene dielectric. In the past, magnetos were typically used with wax-impregnated paper capacitors and their insulation resistance would be unlikely to be above 100MΩ, even when new. In fact, your "other" magneto has a far more realistic requirement.

Moreover, if the magneto capacitor has to be tested to such a stringent requirement, we would expect that there would be a specified test procedure which would be to NATA (National Association of Testing Authorities) standard (or CASA).

Having said that, it would be reasonably straightforward to measure such high insulation resistances using the same methodology as employed in our Capacitor Leakage Meter (see Fig.1, page 41, December 2009) but with a bench digital multimeter having an

Query On WIB Connector Termination

The WIB project (SILICON CHIP, November & December 2009, January 2010) looks like world-class work. Congratulations! I aim to build one to control some stuff at home from the office.

I'm just curious about the RJ connector CON2. I see that pair 1 (pins 4 & 5) and pair 4 (pins 7 & 8) are each shorted and then connected via 75Ω resistors to a single 1nF capacitor connected to 0V. I'm guessing this is to avoid parasitic coupling and/or noise pickup problems caused by the two unused pairs in the connected cable, which would otherwise be "floating".

I'll bet that Amphenol know what they're doing but why do they also connect the centre-taps of the Tx and Rx pairs to the same point? Is there any significance in the 75Ω resistor values chosen for what are in fact 100Ω balanced lines. I can see problems with this RC network if connected to a PoE (Power over Ethernet) system. Some of the 75Ω resistors would fry and even if they didn't there would be half the raw DC voltage on the centre-taps.

I downloaded a PDF from Amphenol but there is not much explanation in that and I don't think there is much mention of the internals of CON2 in the article. (J. R., Woy Woy, NSW).

- The termination used in the WIB is the one recommended in the data sheet for the ENC28J60 ethernet controller (available from the Microchip website). The 75Ω resistors and the 1nF capacitor are for EMI reduction and ESD protection and the 1nF (2kV) capacitor connects to the (metal) shield of the connector (chassis GND), not necessarily to circuit ground.

This RJ45 connector is not designed for PoE applications. It would be a problem, as you describe, if PoE simply applied power. However, it does not do so but tests the resistance between the terminals before applying power.

A device configured for PoE must have the correct resistance before it is supplied power by a PoE host (the WIB does not, so the PoE host will not apply power to it).

In any case, the WIB is not designed to work with PoE systems. The corresponding RJ45 connector for PoE would add capacitors in series with the 75Ω resistors.

input impedance of 50MΩ. If there is reader interest, we will detail the method in a future issue.

Difficulty in setting up Insulation Meter

I have just completed building the October 2009 Megohm & Insulation Meter from scratch (PC board to finish). When turned on for the first time the LCD showed the correct dialog etc and all looked fine. I connected the test wire and commenced the setting up process. The 1000V reading showed 103μA.

Not to be outdone, I adjusted the trimpot but this had no effect on the reading. I changed to the 500V setting and the reading was 53.6μA, with the last digit flashing between what looked like 3-6 when the test button was pressed.

I then checked the voltage at test points TP3 (2.48V) & TP1 (3.18) and replaced trimpot VR1, thinking it may be faulty but this gave no improvement.

The meter works but will not allow adjustment via VR1. Also when the test button is pressed, the last two digits of the 999MΩ reading fluctuate/blink just ever so slightly.

I have checked the soldering under magnification and cannot see any dry joints. Any suggestions as to what could be the cause would be appreciated. (S. F., Carina Heights, Qld).

- The voltage readings you are getting are not a cause for serious concern but from your figures it sounds as if the main cause of the deviations is the slightly low voltage at TP1 and the V_{REF+} input of IC3. At 3.18V, this would be making the ADC read at least 2% high.

So to fix this, try replacing the 270Ω resistor (in series with the 5.6kΩ resistor from TP1 to ground) with one of 300Ω, to see if this moves the TP1 voltage nearer to 3.20V. If it moves up

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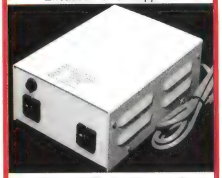

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Maximum Power Output Varies With Mains Voltage

I'm not sure if this has been asked before. I've heard that an amplifier will output more power when the AC mains voltage is higher. Does this also apply to CD/DVD players and PC sound cards etc or do they have a fixed output voltage regardless of the AC voltage? (N. O., via email).

● Most power amplifiers derive their power from the 230VAC mains via a transformer. This provides isolation from the mains and steps down the voltage. The power amplifier supply rails therefore can vary depending on the mains supply voltage. This can mean the amplifier is capable of delivering more power if the mains voltage is high compared to when it is low.

Power amplifiers that are operated from batteries such as in portable radios and car power amplifiers can also output more power when the battery voltage is highest. For cars, this means more power when the battery is charging at around 14.4V compared to when the battery is not being charged and at about 12V.

In fact, the variation with input supply voltage can make a significant difference to the maximum power output that can be delivered by an amplifier. For the DC example above, where the supply voltage is changed from 12V to 14.4V, that is a variation of 20%. However, since power output is proportional to the square of the voltage, the maximum power output that could be delivered by the amplifier would increase by 44% in theory. In practice the increase would be not quite that large but it is still quite significant.

However, there is a little more to the story and the amplifier would only sound slightly louder before the onset of clipping. The reason for this is that hearing is logarithmic in response and since an increase in power output of 44% is only +3dB, it is not a large increase in perceived loudness.

For an amplifier to sound significantly louder, the power difference needs to be around +6B or more, ie, an increase of two or more.

For low-power amplifiers and signal sources such as those found in CD/DVD players and computer sound cards, the supplies are regulated to a fixed voltage. This means that they don't vary with the external power supply (such as the 230VAC mains or a battery). The output from these items is therefore unaffected by mains voltage changes.

too far, you could then try shunting the 300Ω resistor with a high value, to nudge it back down to the 3.20V level.

Insulation qualms on EHT Probe

Thank you for your article on the EHT Probe (SILICON CHIP, April 2010). I was in the process of designing my own and now it seems I may not have to. However, in your design I'm a little concerned about the electrical stress on the PC board (depending on material type) in the gaps between the 10MΩ resistors in the line down each side of the board.

When measuring 25kV, the voltage across these 8mm gaps between conductors would be 7 x 313V, or 2.191kV. I would have thought, where an uncoated board is concerned, that a space of more than 11mm between conductors would have been more appropriate at 2.191kV although I'm willing to admit that my expertise in this area is woefully out of date.

I seem to recall that *Spacing (mm) = (Vpeak x 0.005) + 0.6* was a useful rule-of-thumb formula. Coating the PC board after scrupulous cleaning reduces the spacing requirement to about half although I don't believe heatshrink tubing could be considered to constitute "coating".

I would be grateful for your assurance that 8mm spaces between conductors in these gaps will not lead to tracking difficulties on an uncoated PC board or on the inside surface of the reduced heatshrink tube. (R. C., Ocean Grove, Vic).

● You are quite correct in stating that the voltage drops across the 8mm gaps down each side of the PC board when measuring an input of 25kV would be almost 2.2kV. However, this shouldn't cause a problem within the board material itself, as the specified dielectric strength of modern FR-4 epoxy fibreglass and FR-2 SRBP board materials is over 20kV/mm.

The air surrounding the board should not be much of a problem either, assuming it is dry air of course. The current figure for the dielectric strength of dry air seems to be around 9kV/mm, especially between rounded conductors as we have here. One of the reasons for suggesting that readers fit the assembled board with a heatshrink sleeve is to ensure that any air trapped inside remains relatively dry.

If there is a problem, it would be caused by any dirt, moisture or other impurities on the surface of the board, before the heatshrink sleeve is fitted.

Our testing suggested that a freshly manufactured board would be clean enough to avoid any risk of flashover but if you want to be 'extra careful' you could coat the assembled board with a "conformal coating" of epoxy resin or polyurethane – allowing it to dry thoroughly before the heatshrink sleeving is applied.

Capacitor for USB Electrocardiogram

My son and I built the ECG from the February 2005 issue. Is it possible to use a 220µF 50V RB electrolytic capacitor instead of a 220µF 50V RBLL low-leakage electrolytic capacitor as specified in the article? I've found it difficult to obtain a low-leakage type.

I tried out our ECG but instead of getting the required PQST waveform on the sampler screen I get a thick green straight line. I do not know if using the wrong electrolytic capacitor is causing this. Could you please advise? (J. D., via email).

● It is possible that using a "normal" 220µF/50V electrolytic capacitor instead of the specified low-leakage type is disturbing both the biasing and the gain of the amplifier stage around IC2a, because of the higher leakage current. This would probably give the "flat line" waveform you are getting.

This being the case, and if you cannot obtain a 220µF/50V RBLL electro, we suggest that you try a parallel com-

Display Required For Multiple Car Instruments

Thank you for the range of educational automotive projects of late. But as space is limited in modern cars, could you not have a common display that is switchable between projects as only one lot of information is usually required at any one time. This would save a lot of space when multiple projects are required. (J. O., via email).

● We thought of that exact problem some time ago and came up with the Multi-Purpose Car Scrolling Display. It was published in the December 2008 & January 2009 issues.

bination of RBLL electro's with lower values; say two 100µF/50V RBLL caps in parallel or four 47µF/50V RBLL caps in parallel. The only problem will be fitting them in physically.

Modifications to dimmer projects

I am interested in two projects about dimmers in your fantastic magazine: the Multi-Function Remote-Controlled Lamp Dimmer from April 2009 and the Remote-Controlled Automatic Table Lamp Dimmer from July 2005. The thing is that I don't know exactly what I have to rework to get the dimmer to work for 110VAC/60Hz.

What changes do I need to do in the schematic and what changes do I need to do in the firmware? (R. C., Bogotá, Colombia).

● For the July 2005 Automatic Table Lamp Dimmer, the circuit relies on a nominal 50Hz mains frequency and it locks onto this within a range of ±5%. The software would require some changes for 60Hz operation, including adjustments for the remote control receiving rate.

Initially, line 977 requires a change from 208 to 214 to convert the operation to a faster rate at 33µs instead of 40µs for the 50Hz rate, ie:

movlw D'214' ; initial divider for timer counter

The 220nF X2 capacitor would need to be changed to a 470nF X2 class to provide sufficient supply current. Additionally, the 4.7nF capacitor at pin 6 would need to be 3.9nF.

You can modify the circuit of the April 2009 dimmer to work with 110V 60Hz by changing the following parts: (1) Double the value of the 470nF 250VAC X2 capacitor (you can either use two in parallel or one of double the capacitance). It MUST be X2 rated for 250VAC or 110VAC;

(2) Halve the value of the 3.3Ω 1W resistor (ie, use 1.6MΩ or 1.5MΩ); and (3) Double the value of the 4.7nF capacitor connected to the 3.3MΩ resistor (ie, use a 10nF capacitor in its place).

You should still build the unit and test it at 12VAC as explained in the article, before applying mains power. Note that we have **not tested** the above modifications.

Increasing the output of the DC-DC converter

In the circuit details for the Adjustable DC-DC Converter For Cars (SILICON CHIP, June 2003) it states that the 0.1Ω resistor sets the peak current that flows in the inductor to approximately 3.3A and that the average current delivered to the load via D2 is limited to 2A.

I need 19V at 1.6A to run a small laptop (according to the laptop specs) but the performance graph indicates that the unit will only produce 1.4A at 19V. What can be changed in the circuit to allow a small increase in the output current? (D. J., via email).

● For that small increase in current you could add a 0.47Ω (5W) resistor

. . . continued on page 111

Notes & Errata

Stereo Digital-To-Analog Converter (September-November 2009): the TOSLINK receivers can exhibit instability in some cases, resulting in noise in the audio outputs under no-signal conditions. The cure is to increase the 33pF capacitors between pins 1 & 2 of each TOSLINK receiver to 100pF.

Note also that not all Philips remote control codes use the RC5 protocol. If you set a universal remote control to a Philips code but the DAC does not recognise it, try a different code. You may have to go through several before you find one which works.

Digital Audio Signal Generator (March-May 2010): the original software did not set up the crystal oscillator and PLL correctly. It worked on some dsPIC33 chips but not all. The updated source code and hex file has been provided to kit suppliers and is available on our website (0420310B.hex).

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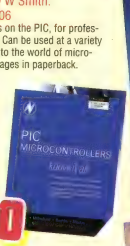

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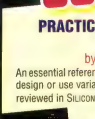

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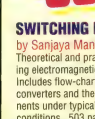

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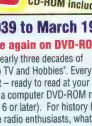

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March 2000: 100W Amplifier Module, Pt.1; Electronic Wind Vane With 16-LED Display; Build A Glowplug Driver.

May 2000: Ultra-LD Stereo Amplifier, Pt.2; LED Dice (With PIC Microcontroller); 50A Motor Speed Controller For Models.

June 2000: Automatic Rain Gauge; Parallel Port VHF FM Receiver; Switchmode Power Supply, Pt.1; Build A 12V Electronic Organ.

July 2000: Moving Message Display; Compact Fluorescent Lamp Driver; Musicians' Lead Tester; Switchmode Power Supply, Pt.2.

August 2000: Theremin: Spinner (writes messages in "thin-air"); Proximity Switch; Structured Cabling For Computer Networks.

September 2000: Swimming Pool Alarm; 8-Channel PC Relay Board; Fuel Mixture Display For Cars; Protoboards – The Easy Way Into Electronics, Pt.1; Cybug The Solar Pty.

October 2000: Guitar Jammer; Breath Tester; Wand-Mounted Inspection Camera; Subwoofer For Cars; Fuel Mixture Display, Pt.2.

November 2000: Santa & Rudolf Chrissie Display; 2-Channel Guitar Preamplifier, Pt.1; Remote Control & Missed Call Alert; Protoboards – The Easy Way Into Electronics, Pt.3.

December 2000: Home Networking For Shared Internet Access; White LED Torch; 2-Channel Guitar Preamplifier, Pt.2 (Digital Reverb); Driving An LCD From The Parallel Port; Index To Vol.13.

January 2001: How To Transfer LPs & Tapes To CD; The LP Doctor – Clean Up Clicks & Pops, Pt.1; Arbitrary Waveform Generator; 2-Channel Guitar Preamplifier, Pt.3; PIC Programmer & TestBed.

February 2001: An Easy Way To Make PC Boards; LVI Pulser Train Controller; 4-Way Infrared Remote Control; Build The Bass Blaster; 2-Metre Groundplane Antenna; LP Doctor – Clean Up Clicks & Pops, Pt.2.

March 2001: Making Photo Resist PC Boards; Big-Digit 12/24 Hour Clock; Parallel Port PIC Programmer & Checkerboard; Protoboards – The Easy Way Into Electronics, Pt.4; Build A Stereo Tape Preamplifier.

April 2001: A GPS Module For Your PC, Dr Video – An Easy-To-Build Video Stabiliser; Tremolo Unit For Musicians; Minimitter FM Stereo Transmitter; Intelligent Nicad Battery Charger.

May 2001: 12V Mini Stereo Amplifier; Two White-LED Torches To Build; Powerful Sine/Square Waveform Display; Using Linux To Share An Internet Connection, Pt.1; Tweaking Windows With TweakUI.

June 2001: Universal Battery Charger, Pt.1; Phonome – Call, Listen In & Switch Devices On & Off; Low-Cost Automatic Camera Switcher; Using Linux To Share An Internet Connection, Pt.2.

July 2001: The HeartMate Heart Rate Monitor; Do Not Disturb Telephone Timer; Pic-Toc – A Simple Alarm Clock; Fast Universal Battery Charger, Pt.2; Backing Up Your Email.

August 2001: DI Box For Musicians; 200W Mosfet Amplifier Module; Headlight Reminder; Simple Frequency Counter Module; Using Linux To Share An Internet Connection, Pt.3.

September 2001: Making MP3s; Build An MP3 Jukebox, Pt.1; PC-Controlled Musical Fountain; Regulated Noise Source For Testing; Electronic Microphone; Using Linux To Share An Internet Connection, Pt.4.

November 2001: Ultra-LD 100W/Channel Stereo Amplifier, Pt.1; Neon Tube Modulator For Cars; Audio/Video Distribution Amplifier; Build A Short Message Receiver; Practical Tips For The PC.

January 2002: Touch And/Or Remote-Controlled Light Dimmer, Pt.1; A Cheap 'n'Easy Motorbike Alarm; 100W /Channel Stereo Amplifier, Pt.3; Build A Raucous Alarm; FAQs On The MP3 Jukebox.

February 2002: 10-Channel IR Remote Control Receiver; 2.4GHz High-Power Audio/Video Link; Touch And/Or Remote-Controlled Light Dimmer, Pt.2; Booting A PC Without A Keyboard; 4-Way Event Timer.

March 2002: Mighty Midget Audio Amplifier Module; 6-Channel IR Remote Volume Control, Pt.1; RIAA Pre-Amplifier For Magnetic Cartridges; 12/24 Hour Clock For Computer Enthusiasts.

April 2002: Automatic Single-Channel Light Dimmer; Pt.1: Water Level Indicator; Multiple-Output Bench Power Supply; Versatile Multi-Mode Timer; 6-Channel IR Remote Volume Control, Pt.2.

May 2002: 32-LED Knightrider; The Battery Guardian (Cuts Power When the Battery Voltage Drops); 2-Channel Guitar Preamplifier; Automatic Single-Channel Light Dimmer, Pt.2; Stepper Motor Controller.

August 2002: Digital Instrumentation Software For PCs; Digital Storage Logic Probe; Digital Therm /Thermostat; Sound Card Interface For PC Test Instruments; Direct Conversion Receiver For Radio Amateurs.

September 2002: 12V Fluorescent Lamp Inverter; 8-Channel Infrared Remote Control; 50-Watt DC Electronic Load; Spyware – An Update.

October 2002: Speed Controller For Universal Motors; PC Parallel Port Wizard; Cable Tracer; AVR ISP Serial Programmer; 3D TV.

November 2002: SuperCharger For NiCd/NiMh Batteries, Pt.1; Windows-Based EPROM Programmer, Pt.1; 4-Digit Crystal-Controlled Timing Module.

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December 2002: Receiving TV From Satellites, Pt 1: The Microwave Stereo FM Transmitter: Windows-Based EPROM Programmer, Pt 2; SuperCharger For NiCd/NiMH Batteries; Pt 2; Simple VHF FM/AM Radio.

January 2003: Receiving TV From Satellites, Pt 2: SC480 50W RMS Amplifier Module, Pt 1; Gear Indicator For Cars; Active 3-Way Crossover For Speakers.

February 2003: PortaPal PA System, Pt 1; SC480 50W RMS Amplifier Module, Pt 2; Windows-Based EPROM Programmer, Pt 3.

March 2003: LED Lighting For Your Car, Peltier-Effect Tinnie Cooler; PortaPal PA System, Pt 2; 12V SLA Battery Float Charger; Little Dynamite Subwoofer.

April 2003: Video-Audio Booster For Home Theatre Systems; Three PIC Programmer Kits; Electric Shutter Release For Cameras.

May 2003: Widgybox Guitar Distortion Effects Unit; 10MHz Big Blaster Subwoofer; Printer Port Simulator; PICAXE. Pt 4 (Motor Controller).

June 2003: PICAXE-Controlled Telephone Intercom; Sunset Switch For Security & Garden Lighting; Digital Reactance Tuner; Adjustable DC-DC Converter For Cars; Long-Range 4-Channel UHF Remote Control.

July 2003: Smart Card Reader & Programmer; Power-Up Auto Mains Switch; A "Smart" Mains Flash Trigger; Programmable Timer/Counter.

August 2003: PC Infrared Remote Receiver (Play DVDs & MP3s On Your PC Via Remote Control). Digital Instrument Display For Cars, Pt 1; Home-Brew Weatherproof 2.4GHz WiFi Antenna; PICAXE Pt 7.

September 2003: Robot Wars: Krypton Bike Light; PIC Programmer; Current Clamp Adaptor For DMMs; PICAXE Pt 8—A Data Logger; Digital Instrument Display For Cars, Pt 2.

October 2003: PC Board Design, Pt 1: JV80 Loudspeaker System: A Dirt Cheap, High-Current Power Supply; Low-Cost 50MHz Frequency Meter; Long-Range 4-Channel UHF Remote Control System.

November 2003: PC Board Design, Pt 2, 12AX7 Valve Audio Preamplifier; Our Best Ever LED Torch; Smart Radio Modem For Microcontrollers; PICAXE Pt 9, Programmable PIC-Powered Timer.

December 2003: PC Board Design, Pt 3: Infrared Receiver For Weather Satellites; Laser Light Show; Custom TW Star LEDs; SV Meter Calibration Standard; PIC-Based Car Battery Monitor; PICAXE Pt.10.

January 2004: Studio 350W Power Amplifier Module, Pt.1; High-Efficiency Power Supply For 12AX7 Valve Preamps & BF Preamp Power Supply; Battery & Input Microphone Adaptor For PA Systems; PICAXE-18X-a Channel Datalogger, Pt.1; 2.4GHz Audio/Video Link.

February 2004: PC Board Design, Pt.1: Supply Rail Monitor For PCs; Studio 350W Power Amplifier Module, Pt.2; Assembly Started Tuner For Line Output Transformers; PICAXE-18X 4-Channel Datalogger, Pt.2.

March 2004: PC Board Design, Pt.2: Build The QuickBrake For Increased Driving Safety; 3V-9V (or more) DC-DC Converter; ESR Meter Mk.2, Pt.1; PICAXE-18X 4-Channel Datalogger, Pt.3.

April 2004: PC Board Design, Pt.3: Loudspeaker Level Meter For Home Theatre Systems; Dog Silencer: Mixture Display For Cars; ESR Meter Mk.2, Pt.2; PC/PICAXE Interface For UHF Remote Control.

May 2004: Amplifier Testing Without High-Tech Gear; Component Video to RGB Converter; Programmable Timer Switch For Lowson Star LEDs; Wireless Parallel Port; Poor Man's Metal Locator.

June 2004: Build An RFID Security Module; Simple Fridge-Door Alarm; Courtesy Light Delay For Cars; Automating My Power-Up; Upgraded Software For The PCM Programmer.

July 2004: Silencing A Noisy PC; Versatile Battery Protector; Appliance Energy Meter, Pt.1; A Poor Man's Q Meter; Regulated High-Voltage Supply For Valve Amplifiers; Remote Mixer For Stereo PA Systems.

August 2004: Video Formats: Why Bother?; VAFs New DC-X Generation TV Modulator; Video Enhancer & Y/C Separator; Balanced Microphone Preamp; Appliance Energy Meter, Pt.2; 3-State Logic Probe.

September 2004: Voice Over IP (VoIP) For Beginners: WiFry – Cooking Up 2.4GHz Antennas; Bed Wetting Alert; Build a Programmable Robot; Another CFL Inverter.

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November 2004: 42V Car Electrical Systems: USB-Controlled Power Switch (Errata December 2004); Charger For Deep-Cycle 12V Batteries, Pt.1; Driveway Sentry For Cars; SMS Controller, Pt.2; PICAXE IR Remote Control.

December 2004: Build A Windmill Generator, Pt.1; 20W Amplifier Module: Charger For Deep-Cycle 12V Batteries, Pt.2; Solar-Powered Wireless Weather Station; Bidirectional Motor Speed Controller.

January 2005: Windmill Generator, Pt.2; Build A VB Doorbell; IR Remote Control Checker; 4-Minute Shower Timer; The Pravnitile; Sinom Says Game; VAF DC-7 Generation 4 Kit Speakers.

February 2005: Windmill Generator, Pt.3: USB-Controlled Electrocardiograph; TwinTec Stereo Amplifier; Inductance & Q-Factor Meter, Pt.1; A Yagi Antenna For UHF CB; S2 Battery Charger.

March 2005: Windmill Generator, Pt.4; Sports Scoreboard, Pt.1; Inductance & Q-Factor Meter, Pt.2; Shielded Loop Antenna For AM; Sending Picaxe Data Over A 240V Light Circuit; Vinyl Press' Groove Analyser.

April 2005: Install Your Own In-Car Video (Reversing Monitor); Build A MIDI Theremin, Pt.1; Bass Extender For HiFi Systems; Sports Scoreboard, Pt.2; SMS Controller Add-Ons; A 5S Variable Power Supply.

May 2005: Getting Into Wi-Fi, Pt.1; Build A 45-Second Voice Recorder; Wireless Microphone/Audio Link; MIDI Theremin, Pt.2; Sports Scoreboard, Pt.3; Automatic Stopwatch Timer.

June 2005: Wi-Fi, Pt.2; The Mesmeriser LED Clock; Coolmaster Fridge/Freezer Temperature Controller; Alternative Power Regulor; PICAXE Colour Recognition System; AVR200 Single Board Computer, Pt 1

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September 2005: Build Your Own Seismograph; Bilge Sniffer For Boats; VoIP Analog Phone Adaptor; Mudlark A205 Valve Stereo Amplifier; Pt 2.

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November 2005: Good Quality Car Sound On The Cheap; Pt.1: PICAXE In Schools, Pt.1; Studio Series Stereo Preamplifier; Build A MIDI Drum Kit, Pt.1; Serial I/O Controller & Analog Sampler.

December 2005: Good Quality Car Sound On The Cheap; Pt.2; Building The Ultimate Jukebox, Pt.1; Universal High-Energy Ignition System, Pt.1; MIDI Drum Kit, Pt.2; PIC-Based 433MHz Wireless Thermometer; Studio Series Preamplifier; Pt.2.

February 2006: PC-Controlled Burglar Alarm, Pt.1; A Charger For iPods & MP3 Players; Picaxe-Powered Thermostat & Temperature Display; Build A MIDI Drum Kit, Pt.4; Building The Ultimate Jukebox, Pt.3.

March 2006: PC-Controlled Burglar Alarm System, Pt.2; Low-Cost Intercooler Water Spray System; AVR ISP SocketBoard; Build A Low-Cost Large Display Anemometer.

April 2006: Stereo Preamp Remote Control Module; 4-Channel Audio/Video Preamplifier; Programmable Traffic Light Lighting System, Pt.1; Picaxe Goes Wireless, Pt.1 (Using the 2.4GHz XBee Modules) .

May 2006: Lead-Acid Battery Zapper; Universal High-Energy Ignition System, Pt.2; Passive Direct Injection (Di) Box For Musicians; Picaxe Goes Wireless, Pt.2; Boost Your Digital Camera's Simple Antennae.

June 2006: Pocket A/V Test Pattern Generator; Two-Way SPDIF-to-Toslink Digital Audio Converter; Build A 2.4GHz Wireless A/V Link; A High-Current Battery Charger For Almost Nothing.

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August 2006: Picaxe-Based LED Chaser Clock; Magnetic Cartridge Preamplifier; An Ultrasonic Eavesdropper; Mini Thereman Mk.2, Pt.2.

September 2006: Transferring Your LPs To CDs & MP3s; Turn an Old Xbox into a Media Player; Picaxe Goes Wireless, Pt.3; Galactic Voice Aquarium Temperature Alarm; S-Video To Composite Video Converter.

October 2006: LED Tachometer With Dual Displays, Pt.1; UHF Prescaler For Frequency Counters; Intrared Remote Control Extender; Easy-To-Build 12V Digital Battery Capacity Meter; Lead-Acid Battery Light Alternator.

November 2006: Radar Speed Gun, Pt.1; Build Your Own Compact Bass Reflex Loudspeakers; Programmable Christmas Star; DC Relay Switch; LED Tachometer With Dual Displays, Pt.2; Picaxe Net Server, Pt.3.

December 2006: Bringing A Dead Cordless Drill Back To Life; Cordless Power Tool Charger Controller; Radar Speed Gun, Pt.2; Super Speedo Corrector; 12/24V Auxiliary Battery Controller.

January 2007: Versatile Temperature Switch; Intelligent Car Air-Conditioning Controller; Remote Telltale For Garage Doors; Intelligent 12V Charger For SLA & Lilo Batteries.

February 2007: Remote Volume Control & Preamplifier Module, Pt.1; Simple Variable Boost Control For Turbo Cars; Fuel Cut Defeater For The Boost Control; Low-Cost 50MHz Frequency Meter, Pt.1.

March 2007: Programmable Ignition System For Cars, Pt.1; Remote Volume Control & Preamplifier Module, Pt.2; GPS-Based Frequency Reference, Pt.1; Simple Ammeter & Voltmeter.

April 2007: High-Power Reversible DC Motor Speed Controller; Build A Jacob's Ladder; GPS-Based Frequency Reference, Pt.2; Programmable Ignition System, Pt.2; Dual PICAXE Infrared Data Communication.

May 2007: 20W Class-A Amplifier Module, Pt.1; Adjustable 1-32V Regulated Power Supply; VU/Peak Meter With LCD Bargraphs; Programmable Ignition System For Cars, Pt.3; GPS-Based Frequency Reference Modifications; Throttle Interface For The DC Motor Speed Controller.

June 2007: 20W Class-A Amplifier Module, Pt.2; Knock Detector For The Programmable Ignition; 4-Input Mixer With Tone Controls; Frequency-Activated Switch For Cars; Battery Desulphator Project.

July 2007: How To Cut Your Greenhouse Emissions, Pt.1; 6-Digit Nixie Clock, Pt.1; Tank Water Level Indicator; A PID Temperature Controller; 20W Class-A Stereo Amplifier; Pt.3; Making Panels For Projects.

August 2007: How To Cut Your Greenhouse Emissions. Pt.2; 20W Class-A Stereo Amplifier; Pt.4; Adaptive Turbo Timer; Subwoofer Controller; 6-Digit Nixie Clock, Pt.2.

September 2007: The Art Of Long-Distance WiFi; Fast Charger For NiMH & Nicad Batteries; Simple Data-Logging Weather Station, Pt.1; 20W Class-A Stereo Amplifier, Pt.5.

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November 2007: PIC-Based Water Tank Level Meter, Pt.1; Playback Adaptor For CD-ROM Drives, Pt.1; Rolling Code Security System, Pt.2.

December 2007: Signature Series Kit Loudspeakers; IR Audio Headphone Link; Enhanced 40s Voice Recorder Module; PIC-Based Water-Tank Level Meter, Pt.2; Playback Adaptor For CD-ROM Drives, Pt.2.

January 2008: Swimming Pool Alarm; Emergency 12V Lighting Controller; Minispot 455kHz Modulated Oscillator; Water Tank Level Meter, Pt.3; Improving The Water Tank Level Meter Pressure Sensor.

February 2008: UHF Remote-Controlled Mains Switch; UHF Remote Mains Switch Transmitter; A PIR-Triggered Mains Switch; Shift Indicator & Rev Limiter For Cars; Mini Solar Battery Charger.

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April 2008: Charge Controller For 12V Lead-Acid Or SLA Batteries; Side Flash Trigger For Digital Cameras; 12V Battery-Current DC Motor Speed Controller, Pt.2; Two-Way Stereo Headphone Adaptor.

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June 2008: DSP Musicolour Light Show, Pt.1; PIC-Based Rixitimer Mk.4; USB Power Injector For External Hard Drives; Balanced/Unbalanced Converter For Audio Signals; A Quick'n'Easy Digital Slide Scanner.

July 2008: DSP Musicolour Light Show, Pt.2; A PIC-Based Musical Tuning Aid; Stand-Alone PIC Project For PCs & MP3 Players; Bridge Adaptor For Stereo Power Amplifiers.

August 2008: Ultra-LD Mk.2 200W Power Amplifier Module, Pt.1; Planet Jupiter Receiver; LED Strobe & Contactless Tachometer; Pt.1; DSP Musicolour Light Show, Pt.3; Printing In The Third Dimension.

September 2008: Railpower Model Train Controller, Pt.1; LED/Lamp Flasher; Ultra-LD Mk.2 200W Power Amplifier Module, Pt.2; DSP Musicolour Light Show, Pt.4; LED Strobe & Contactless Tachometer, Pt.2

October 2008: USB Clock With LCD Readout, Pt.1; Digital RF Level & Power Meter; Multi-Purpose Train Timer; Railpower Model Train Controller, Pt.2; Picaxe-08M 433MHz Data Transceiver.

November 2008: 12V Speed Controller/Lamp Dimmer; USB Clock With LCD Readout, Pt.2; Wideband Air-Cored 40W High-Quality Inductor; Infrared Remote For The DSP Musicolour; The AirNav RadarBox.

December 2008: Versatile Car Scrolling Display, Pt.1; Test The salt Content Of Your Swimming Pool; Build A Brownout Detector; Simple Voltage Switch For Car Projects.

January 2009: Dual Booting With Two Hard Disk Drives; USB-Sensing Mains Power Switch; Remote Mains Relay Mk.2; AM Broadcast Band Loop Antenna; Car Scrolling Display, Pt.2; 433MHz UHF Remote Switch.

February 2009: Digital Radio Is Coming, Pt.1; Tempmaster Electronic Thermostat; Remote Mains Relay Mk.2; Remote Mains Relay Mk.2; Programmable Time Delay Flash Trigger; Car Scrolling Display, Pt.3.

March 2009: Reviving Old Laptops With Puppy Linux; Digital Radio Is Coming, Pt.2; A GPS-Synchronised Clock; Theremin Mk.2; Build A Digital Audio Oscilloscope; Learning about Picaxe Microcontrollers

April 2009: Digital Radio Is Coming, Pt.3; Wireless Networking With Ubuntu & Puppy Linux; Remote-Controlled Lamp Dimmer; School Zone Speed Alert; USB Printer Share Switch; Microcurrent DMM Adaptor.

May 2009: A 6-Digit GPS-Locked Clock, Pt.1; 230VAC 10A Full-Wave Motor Speed Controller; Precision 10V DC Reference For Checking DMMs; UHF Remote 2-Channel 230VAC Power Switch.

June 2009: Mal's Electric Vehicle Conversion; High-Current, High-Voltage Battery Capacity Meter, Pt.1; GPS Driver Module For The 6-Digit Clock; A Basic Break-Out Board For Propeller; Hand-Held Digital Audio Oscillator.

July 2009: The Magic Of Water Desalination; Lead-Acid Battery Zapper & Desulphator; Hand-Held Metal Locator; Multi-Function Active Filter Module; High-Current, high-Voltage Battery Capacity Meter, Pt.2.

August 2009: Converting A Uniden Scanner To Pick Up ASI Signals; Mini USB Sound Card & Scope/Recorder/Player; Lead-Acid Battery Condition Checker; 3-Channel UHF Rolling-Code Remote Control, Pt.1.

September 2009: High-Quality Stereo Digital-To-Analog Converter, Pt.1; WideBand Log Senior Controller For Cars, Pt.1; Autodim Add-On For The GPS Clock; 3-Channel UHF Rolling-Code Remote Control, Pt.2.

October 2009: Universal I/O Board With USB Interface; High-Quality Stereo Digital-To-Analog Converter, Pt.2; Digital Megohm & Leakage Current Meter; Multi-Function GPS Receiver For Cars, Pt.2.

November 2009: Web Server In A Box, Pt.1; Twin-Engine Speed-Match Indicator For Boats; High-Quality Stereo Digital-To-Analog Converter, Pt.3; A Dead-Simple Masthead Amplifier.

December 2009: Voltage Interceptor For Car Sensors, Pt.1; One-Or-Nine Switch For Multi-Element Capacitor Gauge Heads; Build LCD-Big 7-Segment LED Panel Meter Display; Web Server In A Box, Pt.2.

January 2010: Multi-Function GPS Car Computer, Pt.1; Balanced Output Board For The Stereo DAC; Precision Temperature Logger & Controller, Pt.1; Advanced Interface For Cars With OBDII; Web Server In A Box, Pt.3.

February 2010: OBDII Interface For Laptop Computers; Milliohm Adaptor For DMMs; Internet Time Display For the Web; Multi-Function GPS Car Computer, Pt.2; Precision Temperature Logger & Controller, Pt.2.

March 2010: Solar-Powered Alarm For Sheds & Boats; Digital Audio Signal Generator, Pt.1; Low-Capacitance Adaptor For DMMs; Accurate Thermometer/Thermostat.

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Ask Silicon Chip – continued from page 101

in parallel with the 0.1Ω 5W resistor. No other changes are needed.

Capacitors for fan speed controllers

I wish to know if it is possible to purchase the capacitor module that controls the speed of ceiling fans. I have six fans that need attention, mainly with the second speed setting. I have checked the capacitance of some units and found that the value of the unit in some cases is half of what it should be, eg, 2.5µF reads 1.2µF. I have checked the fan motor capacitors and they are within 5% of their rated value.

I visited a couple of electrical shops here and they want to sell me a complete controller for nearly the price of a new fan. There is nothing wrong with the fans or control switch. Only the capacitor block is faulty, so is it possible to just buy the module? The value required is 1.8µF and 2.5µF (I know that there are other values for other fans).

The fan I have is Wattmaster 3-speed ceiling model. I have checked on the web at Wattmaster but can't seem to find any info regarding these capacitors. (B. H., Mackay, Qld).

● Depending on the size of the fan, motor start capacitors could be used for large fans or the mains rated polypropylene X2 capacitors can be used for smaller fans. Ideally, use the same type of capacitor that is already in the fan speed controller.

Polypropylene X2 capacitors are available from Farnell (**www.farnell.com.au**) Cat. numbers 111-2847 for 1.5µF and 111-2849 for 2.2µF. You can add a 330nF across each to make up the values to 1.8µF and 2.5µF. A 330nF X2 capacitor is Cat. 111-2844.

For motor-start capacitors, see Cat. 119-0561 for 1.5µF and 119-0562 and 119-0563 for 2µF and 3µF values.

Idea for GPS computer

A major problem that I have with my car is that the speedo is significantly inaccurate (but apparently just not bad enough to trigger a warranty replacement). Whilst I know it is inaccurate and I know approximately by how much, it still makes it impossible to reliably know the speed I am travelling.

Your GPS car computer is a beautiful solution to this problem except that it requires a constant GPS lock to operate. My project suggestion is to use one of the general purpose I/Os to connect to a speed related input from the car. During GPS lock, the device could calculate the pulses per km for the input and then use the input during periods of GPS loss to continue running the computer, despite the loss of GPS sync.

Auto detecting the pulses per km during GPS lock has two advantages. First, there is no configuration to make the input work; no need to set the pulses per kilometre. Second, as tyre pressures change over time and tyres wear etc, the auto-configuration during GPS lock ensures accuracy over time regardless of a slight shifting in the pulse rate. You now have a device that allows your GPS computer to operate most of its current functions without constant GPS lock.

In a modern car I know of no reason this could not be done by the manufacturers in the engine computer with the addition of the GPS chip. The excuse of needing to over-read speed in order to protect the driver from breaking the law when tyres wear is a complete fallacy when it would be so simple (and cheap) to fix. (A. H., via email).

● There's another issue here. Although speedos are designed to be optimistic under the Australian Design Rules, the odometer is usually highly accurate. So if you correct the speedo's reading, you will actually reduce the reading of the odometer; not by much but it is there. In fact, if the ADRs were updated, it would be easy for car manufacturers to comply.

The ADRs should be updated because many people these days are using their GPS to accurately set their cruise control to travel exactly at the speed limit. SC

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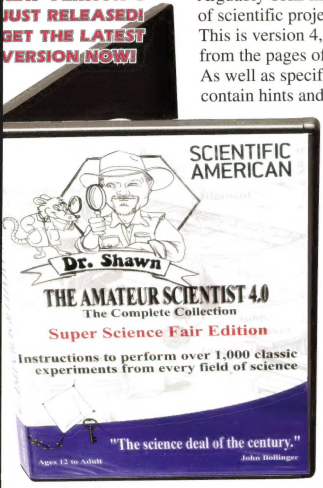

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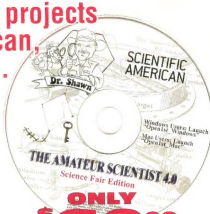

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